

**TECHNO-VERNACULAR CREATIVITY, INNOVATION AND LEARNING IN  
UNDERREPRESENTED ETHNIC COMMUNITIES OF PRACTICE**

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Presented to  
The Academic Faculty

By

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**TECHNO-VERNACULAR CREATIVITY, INNOVATION AND LEARNING IN  
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### **Dedication**

This dissertation is the realization of a long-term goal that would not have been possible without words of encouragement and love from my extended family and special friends.

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## LIST OF ABBREVIATIONS

ABR	..... Arts-Based Research
ARCS	..... Attitude, Relevance, Confidence, Satisfaction
ATTI	..... Attitude
CGT	..... Constructivist Grounded Theory
CONF	..... Confidence
CSABL	..... Culturally Situated Arts-Based Learning
CSDTs	..... Culturally Situated Design Tool
DCS	..... Drew Charter School
ECoP	..... Ethnic Communities of Practice
IMMS	..... Instructional Materials Motivational Survey
LMS	..... Lithonia Middle School
PAR	..... Participatory Action Research
PMM	..... Personal Meaning Maps/Mapping
RELE	..... Relevance
SATI	..... Satisfaction
STEAM	..... Science, Technology, Engineering, Art, Mathematics
STEM	..... Science, Technology, Engineering, Mathematics
TVC	..... Techno-Vernacular Creativity
UEG	..... Underrepresented Ethnic Group

## SUMMARY

Techno-Vernacular Creativity (TVC) refers to cultural art and technology made by underrepresented ethnic artists for their own entertainment and expression. This thesis identifies the ‘techno-vernacular’ as an area of practice and investigates the characteristics of this tradition of practice and its application in learning. This study explores the hypothesis that Techno-Vernacular Creativity can play an important role in helping underrepresented ethnic groups (UEGs) – Indigenous, or African and Latino Diasporas – generate the interest and intrinsic motivation they need to engage in Science, Technology, Engineering, Art and Mathematics, or STEAM. To investigate this theory I developed a research model that builds on successful and proven methods in three key areas: a) culturally situated design, which connects vernacular art and crafts with standards-based STEM principles and allows users to simulate and develop their own creations; b) art-based learning, which is effective in stimulating the development of 21st century skills such as creativity, learning, and innovation; and c) educational applications of new technologies. This dissertation consists of a study involving four workshops conducted between 2013 and 2014 that sought to examine the impact of these combined methods on UEG learning in STEAM. Findings show that this combination led to an increase in interest and motivation among UEGs. This study demonstrates the connection between technical literacy, diversity, and culture through TVC taxonomy and a learning ecology for teaching STEAM. This research aims to make a significant contribution to interdisciplinary education by bringing the culturally situated design and arts-based

learning communities to STEAM through the learning sciences and to further scientific understanding of UEG interest and motivation as a model to inform future research.

# CHAPTER 1: INTRODUCTION

## 1.1.Overview

Though often overlooked in mainstream studies, there are rich traditions of practices among underrepresented ethnic communities of practice (ECoPs) that we identify as examples of Techno-Vernacular Creativity, or TVC, generated by the work of underrepresented ethnic practitioners that engage Science, Technology, Engineering, Art and Mathematics (STEAM). Techno-Vernacular Creativity—cultural art and technology by ECoPs—engages underrepresented ethnic groups (UEGs) – Indigenous, or African and Latino Diasporas – that, as studies show, are increasingly uninterested and disengaged in STEM [Scott, Sheridan & Clark, 2014; Emdin, 2007; Brand, Glasson, & Green, 2006]. Extensive research of TVC and its key characteristics informed culturally situated arts-based learning strategies that were used to conduct workshops to examine the impact of TVC on UEG learning in STEAM. [Fig. 1]

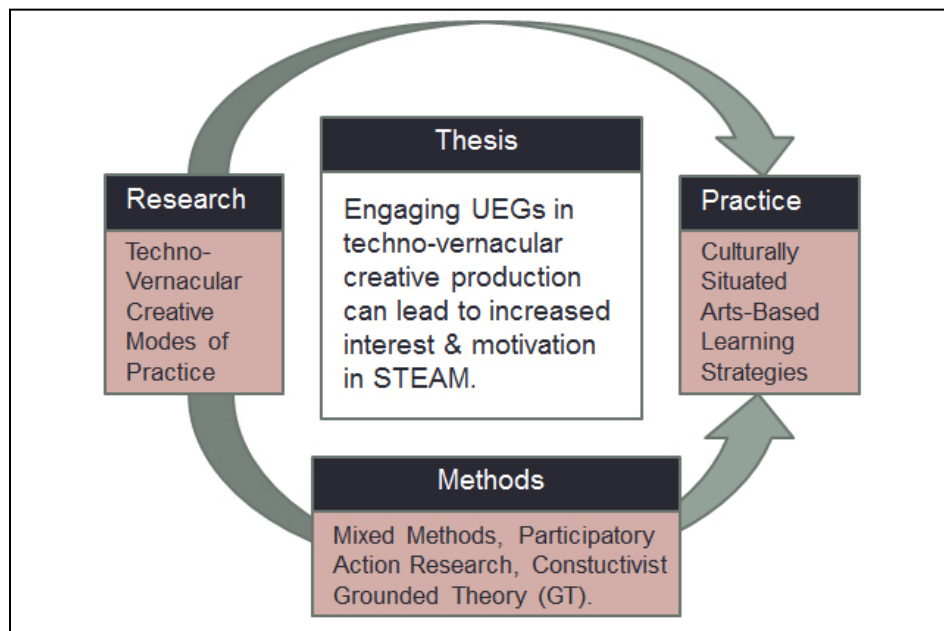


Figure 1: Dissertation plan with thesis statement and research components.

This chapter describes a plan of action that responds to specific challenges of the target group. Subsequent chapters describe theories; prior research and the research methods used to present a final analysis, results and a conclusion to this study.

## 1.2. Key Concepts

Before describing this study's research methodology and plan of action, it is important to define the key concepts that will support and strengthen my thesis. Techno-Vernacular Creativity (TVC) brings to the forefront innovations by underrepresented ethnic communities of practice, or defined groups of people who share a craft or a profession [Wenger, 1998]. Although primarily focused on the African Diaspora and the Black Atlantic (see Gilroy, 1993) this research extends to Latino and Indigenous groups who are affected by aspects of technocultural disparity. TVC works produced by underrepresented ethnic communities of practice, or ECoPs, are diverse, social in nature, and encourage creative expression and innovation.

TVC works made from local materials by ECoPs using Do It Yourself (DIY) methods produce innovations that are specific to place, people and culture. This study includes contributions to the Arts – not only literature, performance, film/video, and visual arts – but also Digital Media that can be created, viewed, distributed, modified and stored on computers. TVC works have personal meaning for the people who make, view, or use them. Modes or qualities of creativity and innovation that distinguish TVC from mainstream technology research and development include

- **Reappropriation** or the cultural process by which UEGs *reclaim* artifacts from dominant culture and the environment. For example, artists who use or alter commercial images (e.g. ads, logos) in their work.

- **Improvisation** or spontaneous and inventive use of materials. For example, practitioners who use *on-the-spot* techniques to make graphic, contemporary quilts and quilted projects.
- **Conceptual remixing**, bricolage, tinkering, or making do with whatever is on hand. For example, artists who combine different, often seemingly disparate knowledge sets, artifacts, identities, and practices.



Figure 2: Techno-Vernacular Creativity “Wordle” drawn from research by Nettrice Gaskins.

The combination of these creative modes can result in the invention of new practices, works, or performance modes. [Fig. 2] Some examples of practitioners engaging in techno-cultural production include

- Ben Hardy and Cliff Vaughns who customized choppers for the characters 'Captain America' and 'Billy' featured in the 1969 movie *Easy Rider*.
- Chicano (Mexican American) engineers who developed hydraulic automobile suspension systems, a distinguishing feature of modern lowrider culture.

- DJ Grandmaster Flash who is credited with the invention of the first cross-fader or audio mixer by reclaiming parts from a junkyard [Price, 2006].
- Hip-hop pioneer and artist Rammellzee who designed costumes made of “technological and industrial scraps” [Dery, 1999].
- Kelvin Doe, also known as DJ Focus, a young African engineer who taught himself engineering and built his own radio station [Dahad, 2013].

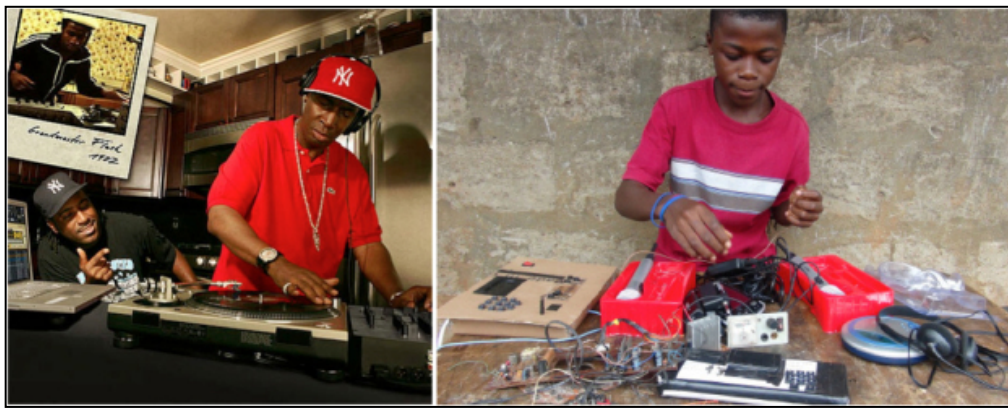


Figure 3: Left: DJ Grandmaster Flash (Joseph Sadler), Right: DJ Focus (Kelvin Doe).

These inventions build upon, counter, or expand mainstream definitions of technology, through the practical application of knowledge, learning and the production of vernacular art and crafts from underrepresented ethnic communities. As a teenager, DJ Grandmaster Flash (Joseph Sadler) began experimenting with electronics in his home and neighborhood, eventually developing and mastering innovations that are considered standard DJing techniques today [Price, 2006]. Sierra Leonean teenager Kelvin Doe (DJ Focus) experimented with discarded pieces of scrap to build transmitters, generators, and batteries [Dahad, 2013]. The creative innovations of Sadler, Doe, other underrepresented ethnic artists and practitioners demonstrate the informal engagement of UEGs in STEM



in ways that are typically not classified as “information technology,” “science,” or “engineering.” [Fig. 3]

The analysis of these innovations contributes to a broader epistemology and creative process through which TVC practitioners such as visual artists, designers, DJs, and b-boys/b-girls (breakdancers) produce images, symbols, objects, performances, and sounds [Roth, 2010; Pearl, 2009; Baudrillard, 2005; MacKay, 2002; Dery, 1993]. This study presents a TVC taxonomy and learning ecology framework (see Barron, 2006) using works that combine digital and non-digital materials in ways that are antithetical to arguments made by researchers that historically marginalized, or underrepresented ethnic groups lack the technical skill to narrow the “digital divide” [Tapscott, 1998; NTIA, 1995]. This research grounds and broadens theory by scholars such as Rayvon Fouché (2006) who are concerned with specific technical UEG engagements by casting a wider net to include innovations that redefine mainstream technology.

### **1.3. Thesis Statement**

This study addressed a key research question:

**Does Techno-Vernacular Creativity within an informal learning environment (ILE) increase interest and intrinsic motivation in ethnic groups who are underrepresented in STEAM?**

This research explored the hypothesis that Techno-Vernacular Creativity can play an important role in helping underrepresented ethnic groups – Indigenous, or African and Latino Diasporas – generate the interest and intrinsic motivation they need to engage in Science, Technology, Engineering, Art and Mathematics, or STEAM.

To investigate this theory I developed a research model that builds on successful and proven methods in three key areas: a) culturally situated design, which connects vernacular art and crafts with standards-based STEM principles and allows users to simulate and develop their own creations; b) art-based learning, which is effective in stimulating the development of 21st century skills such as creativity, learning, and innovation; and c) educational applications of new technologies that can be used to create new openings for learning, as opposed to conventional learning pathways which the target population may perceive to be closed to them. [Fig. 4] These existing methods have all been successful in the past. This study is novel in that it combines all of these approaches to address prevalent educational issues such as technical literacy, diversity, culture and identity through a new framework for studying and teaching STEAM. This includes making post-study recommendations for future research that may include a longitudinal study of the target group to assess progression into STEAM post-secondary study and skills for the 21<sup>st</sup> century workforce.

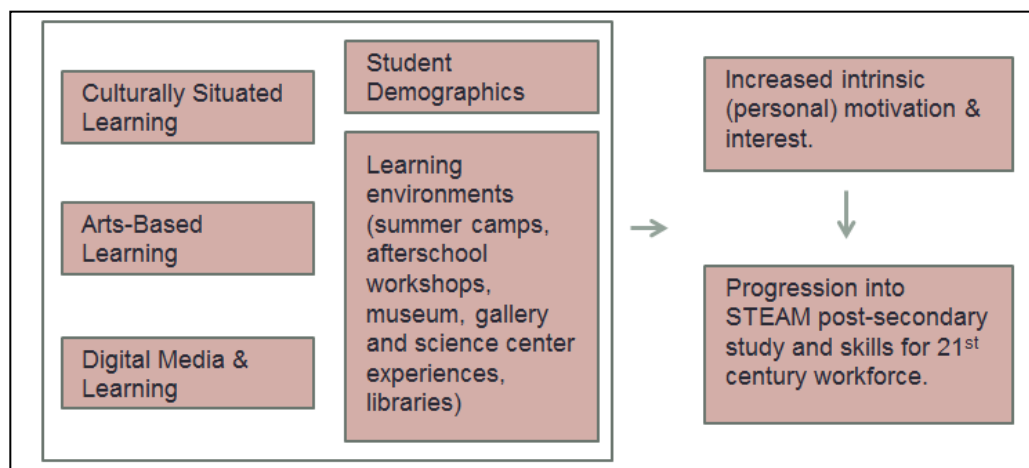


Figure 4: Theory of change logic model that frames the present study;  
Developed with Tom McKlin of The SageFox Consulting Group, LLC.

#### **1.4. Plan of Action**

Learning innovations such as workshops that use TVC practices have the potential to be a rich resource for STEAM education. Artists from underrepresented ECoPs bring a wide range of contextually rich global experiences to learning activities, including culturally responsive perspectives on what defines an informal learning environment, how the environment is valued, and how learners engage in a process of inquiry. The aim of this dissertation is to employ an action-centered research strategy to:

1. Build a research model that directly responds to issues and opportunities raised by researchers and practitioners in a professional workshop, interviews and presentations I conducted regarding Techno-Vernacular Creativity and STEAM.
2. Conduct learning interventions, in the form of workshops to support culturally situated arts-based learning in informal learning environments (ILEs).
3. Build a scaffold between culture, the Arts and STEM to engage learners from UEGs, using the creative practices of artists from underrepresented ECoPs.
4. Identify culturally responsive methods to assess Techno-Vernacular Creativity in culturally situated arts-based learning activities.
5. Build capacity for sustained collaboration across different learning communities for the benefit of research, creative practice and education.

For this study, I conducted four workshops between 2013 and 2014 that sought to examine the impact of these combined methods with TVC on UEG learning in STEAM. This includes a National Science Foundation (NSF) sponsored professional workshop at Georgia Tech with STEAM experts. As per requirement by the NSF an external evaluator

was employed to assess whether or not the workshop goals were met. With oversight by principal investigator Celia Pearce I led a project team that worked with external evaluator Tom McKlin to design instruments for the workshop. I designed a website, schedule and other materials for the workshop. Details regarding the workshop plan and design are included in the methodology of the overall study (see Chapter 4 Methods).

In addition to the professional workshop, I conducted three workshops with 4<sup>th</sup>-8<sup>th</sup> grade students in two schools in the metropolitan Atlanta area. For these workshops, I developed instructional materials, metrics and self-assessment questionnaires for the participants. Materials included toolkits, design templates, visual stimuli, and brainstorming activities. I worked with graduate students in the Synaesthetic Media Lab (synlab) at Georgia Tech and the culturally situated design tool (CSDT) community at Rensselaer Polytechnic Institute (RPI) to provide participants with access to culturally situated design applications in the workshops. Descriptions of these materials and processes are included in Chapter 4 (Methods).

Chapters 2 and 3 comprise of an analysis of research, practices, critical reflections, and resources related to Techno-Vernacular Creativity and innovation to support culturally responsive STEAM teaching and learning in informal (and formal) learning environments. This study compliments and builds upon the important work of scholars such as Rayvon Fouché (black vernacular creativity), Maude Southwell Wahlman (vernacular art and crafts), and cultural studies/social theory work by W.E.B. Du Bois. Building on these prior theories, this chapter develops a new theory of TVC to support culturally situated arts-based learning approaches. The study combines this work with arts-based research (ABR) in an effort to reconceptualize the potential of arts-based

practices to generate new curriculum approaches for STEAM education targeted to underrepresented ethnic learners. Finally, this chapter investigates UEG engagement in STEAM through culturally responsive instruction and digital media to support specific motivational categories (see Keller, 2010:45), especially Attention, Relevance, Confidence, Satisfaction, or the ARCS motivational model.

Chapter 4 explains the methods used when researching models and developing materials for the study. Different informal learning strategies were combined to create a research model that matched interest and intrinsic motivation categories with inquiry prompts or questions based on works presented in classroom presentations and a museum exhibition. The project measured how multiple sources of an overall experience contributed to participants' understanding of meaning making processes. Participants completed projects that explored TVC modes of practice such as improvisation and conceptual remixing. [Fig. 5]

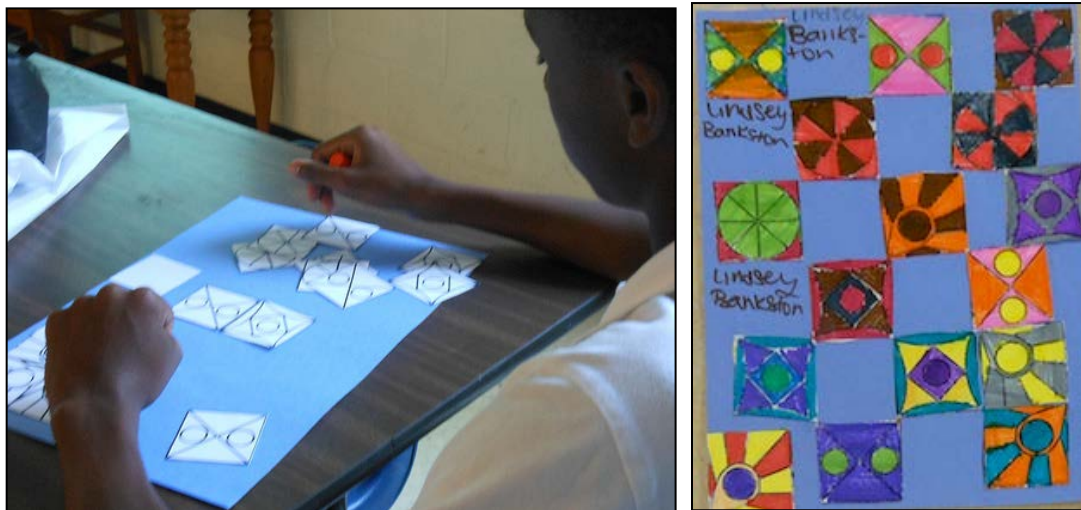


Figure 5: Vision mapping activity at Lithonia Middle School with 6<sup>th</sup> grade students.

The learning workshops for this study responded to the most typical learning issues exhibited by UEGs in informal learning settings such as lack of engagement in

STEM-related activities. Workshops linked TVC practices to informal learning strategies to make STEM more accessible to UEGs using culturally situated arts-based learning techniques such as close-looking at art and simulating artwork and cultural designs using mobile apps, culturally situated design tools, and a tangible multi-touch device. Several data collection methods were used, including participant observations, semi-structured interviews, retrospective pre-post self-assessment, and the collection of workshop materials. Participants' self-gauged success in using STEAM concepts in their projects, reflected on the effectiveness of learning these concepts to meet their interests as a requisite for interest and intrinsic motivation including:

1. Understanding of culturally responsive information in STEAM subjects,
2. Identification with these concepts as they relate to participants' needs, interests, goals, abilities, and cultural backgrounds,
3. Understanding of who can do STEAM and why it is relevant.

The remaining chapters present a final analysis, results, discussion and a conclusion to the study. This project makes at least three contributions to bring the culturally situated design and arts-based learning communities to STEAM through the learning sciences. First, the study contributes a culturally responsive approach to informal learning, combining culturally situated design strategies, arts-based research, and Techno-Vernacular Creativity, TVC production as a means for engaging UEGs in STEAM. This project used culturally responsive instruction (see Ladson-Billings, 2000; Lee, 2007; Gay, 2010) to make TVC concepts accessible to underrepresented ethnic learners using different approaches described in Chapter 2.

Second, the cultural and historical nature of TVC relates not only to the accumulation of artifacts, concepts and practices, but also to the identification of specific interest and motivation characteristics among UEGs. As a second contribution, this study identifies and uses TVC modes as part of a research agenda and a fully implemented pilot learning workshop with a sample of late elementary and middle school students from UEGs in informal and formal learning settings. So often, the interests and activities of this population are overlooked as potential opportunities to enhance STEAM learning. The study contributes toward a better understanding of this group of learners.

Finally, a long-term goal for this research is progression of UEGs in STEAM postsecondary study and skills for the 21st century workforce. This study identifies ways through which TVC can help improve underrepresented ethnic learners' capacity to find meaning, identify their own questions, and re-engage concepts in STEAM. While this is an enormous undertaking, the study is a small step in this direction.

### **1.5. Problem Statement**

Historically, the digital divide described the inequality between groups, broadly construed, in terms of access to, use of, or knowledge of information and communication technologies [NTIA, 1995]. The digital divide also describes various social and cultural factors that shape access to technological resources such as the dearth of relevant content that reflects the experiences of potential users [Nelson & Tu, 2001]. While gaps still remain, the digital divide is narrowing [Zickuhr & Smith, 2012]. UEGs are the most numerous and active users of the mobile web –from a smartphone, tablet computer, or mobile network [Zickuhr & Smith, 2012]. Despite this development, researchers note that the production of new technologies by members of ethnic communities is still relatively

rare [Sanders, 2012]. According to some [Hargittai and Walejko, 2008; Schradie, 2009] the next frontier is bridging the participation divide.

“They [UEGs] need opportunities to create, share, and distribute content rather than just consume content. They need skills related to creating new technology, writing new technology and leveraging technology to solve the problems of their communities. [S. Craig Watkins via Steve Brooks, 2011]

Research shows that historically marginalized groups such as UEGs have unique learning and meaning making experiences that differ from more mainstream groups [Scott, Sheridan & Clark, 2014; Banks, 2007]. They employ technologies for very specific goals, linked often to their histories and social locations [Nelson & Tu, 2001]. Studies show that while underrepresented minority enrollment in postsecondary schools is increasing, and UEGs are more engaged in technology such as mobile applications [Ito, 2009; Smith, 2011] and cultural art [Nunes et al., 1993; Noah, 1997; Stoval, 2006; Roth, 2009; Valle & Weiss, 2010], STEM achievement of these students continues to decrease [Brand, Glasson, & Green, 2006; Emdin, 2007]. This study addresses the vulnerability of this population to societal influences that inevitably assert dominant cultural values and norms. This study argues for the importance of understanding multiethnic and multilingual qualities of culturally diverse groups as they relate to both art and technology.

### **1.6. Significance of the Problem**

The contributions of this study would be of interest to scholars in Arts Based Research and Learning Sciences as well as to cultural studies scholars, particularly in



African Diaspora, Latino Diaspora and Indigenous Studies. Studies on the integration STEAM are recent areas of research in the field of Educational Studies, to which this study would be significant. STEAM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with artistic works and cultural practices as students apply science, technology, engineering, art and mathematics in contexts that make connections between school, community, personal interests and the global marketplace.

Recent studies regarding STEAM integration have largely considered the deployment of this domain as an expansion of transdisciplinary knowledge, exploring the multifaceted issues and challenges facing practitioners who go beyond, or work between disciplines [Henriksen, 2014]. My study contributes to this research by considering the role that culture and art plays among underrepresented ethnic learners. From this perspective, therefore, success is not starting with academic achievement outcomes; rather success starts with demonstrating the ways in which vernacular art, crafts and technology, more broadly defined, demonstrate a capacity not only to engage UEGs in STEM learning, but also to affect positive learning outcomes among the target group.

To better understand Techno-Vernacular Creativity, learning and innovation, my study explores a broader definition of technology and technological practices, to include not only those technologies thought to create “revolutions” (see Nelson & Tu, 2001:5) such as computer hardware and software but also cars, devices created from local materials, and other technologies that are pervasive among UEGs. In Chapter 2 I highlight work by underrepresented ECoPs that make creative and innovative use of technologies. These uses are at odds with studies that portray UEGs as most likely to be

only consumers of technology [Jackson, Zhao, et al., 2008]. In order to address this discrepancy these practices need to be further researched and acknowledged as valid forms of technological production. If a link can be established between interest, motivation, and an attitude conducive to engagement with STEM through creativity and innovation, then it should be possible to look toward Techno-Vernacular Creativity as a strategy for increasing UEG interest and motivation in STEM. This is the core hypothesis of this thesis.

Research shows that learning – as a contextual and situational process – is most effective among UEGs when ecological factors, such as “prior experiences, community settings, cultural backgrounds, and ethnic identities of teachers and students, are included in its implementation” [Gay, 2010:21]. Culturally situated design strategies [see Eglash, et al., 2006:347; 2013] challenge the “primitivist” view that indigenous societies use only simplistic technologies. Eglash et al. (2006) describes the role that mathematics plays in the development and evaluation of vernacular art forms and technologies, such as graffiti, breakdancing and music. Holbrook et al. (2008) combine knowledge and methods from the fields of astronomy, anthropology, and history in order to study the practices and traditions of lay experts and non-experts who relate to the sky.

The exploration of Techno-Vernacular Creativity as an activity open to diverse ECoPs provides us with a clearer understanding of the informal patterns that provide meaning for UEGs in everyday life. This prevents us from depending on static interpretations of cultural, art, and technology in contemporary art and education. I argue that Techno-Vernacular Creativity employed by people that are culturally or historically marginalized is a strategy for reinterpreting accepted or established modes and methods.

Techno-Vernacular Creativity can serve as a model for culturally situated design and practice in formal and informal learning environments for UEGs who are increasingly uninterested and disengaged in steam.

## **CHAPTER 2: THEORETICAL FRAMEWORK AND PRIOR RESEARCH**

### **2.1. Overview**

Scholars interpret “vernacular” as a critical theory on everyday practices that are associated with local language, culture, literature and art [Baker, 1984; Gates, 1988]. In rhetorical studies, this is known through Cara Finnegan's work on image vernaculars [Finnegan, 2005]. This study presents a framework of theoretical lenses and strategic objectives to explain how Techno-Vernacular Creativity (TVC) engages underrepresented ECoPs in ways that can lead to the increased STEAM engagement of underrepresented ethnic learners. This framework was used to identify recurrent modes of practice in TVC, as well as themes that illuminate these practices.

Vernacular art and craft production reflects diverse influences and contexts. Underrepresented ECoPs manage their representations—such as images, sounds, performances—in Western society and the global world by using improvisation and reappropriation to engage multiple identities or cultures (conceptual remixing). Researchers seeking a purpose for exploring learning among underrepresented, creative communities of practice can use this framework to look at or analyze cultural and artistic information produced by underrepresented ethnic artists and practitioners.

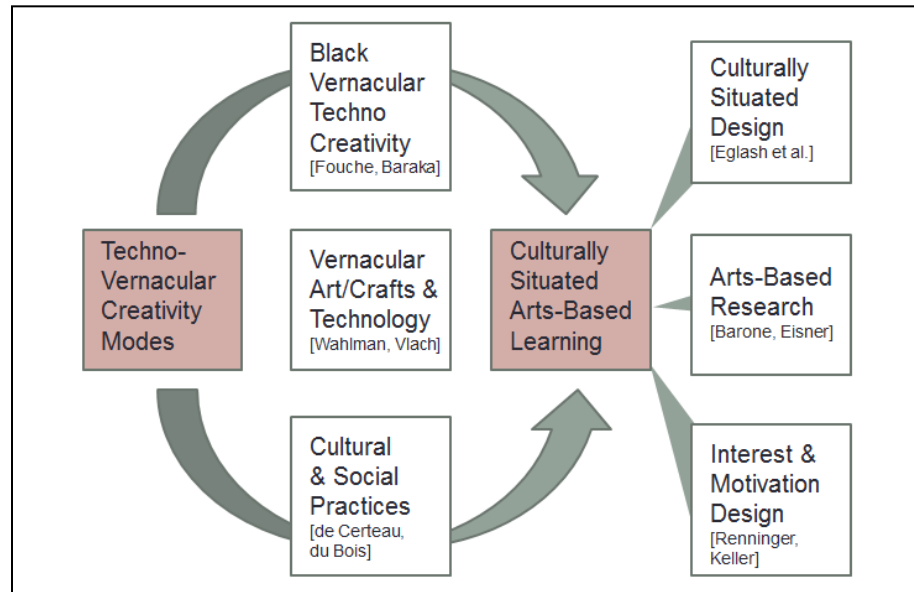


Figure 6: Theoretical framework and prior research.

This framework combined black vernacular technological creativity, vernacular art, crafts and technology, cultural studies and social practices with culturally situated arts-based research strategies to inform future research in interest and motivation. [Fig. 6] This study was intentionally pluralistic, multi-cultural, social, and inclusive of emergent artistic and cultural practices that reveal the complexity in cultural knowledge and a more broadly defined view of technology. This study brought to the forefront creative and innovative practices and projects that can have wider implications in the fields of discourse, and are often described in terms of personal or sociopolitical empowerment [Deterville, 2010; Godrej, 2003].

Rayvon Fouché's theory for black vernacular technological creativity builds on the efforts of such scholars as Amiri Baraka, one of the leaders of the Black Arts Movement [Gates, 1994]. This theory describes African American artists' and practitioners' engagement with vernacular arts and crafts that come from resistance to technology from dominant cultures/societies and strategic appropriations of the material

and symbolic power and energy of technology [Fouché, 2006:641]. This research merged these theories with other underrepresented ethnic cultures' approaches to cultural art and technology in order to show how techno-vernacular creative production methods engage UEGs who are uninterested or disengaged in STEM.

## **2.2. Black Vernacular Technological Creativity**

Rayvon Fouché asserts that, historically, technology has politically, socially, and intellectually silenced African Americans, rendering them defenseless and invisible [Fouché, 2006:640]. African American artists (and artists from other UEGs) combine or subvert existing knowledge systems in order to invent new ways of using, creating and performing with technology. These maneuvers enable practitioners to reclaim different levels of technological agency. Studies of African American creativity often center on vernacular traditions such as technological artifacts, practices, and knowledge that regularly challenge constructed meanings of dominant technology [Fouché, 2006:641]. Fouché (2006:639) and Deterville (2010:54) point to author and critic Amiri Baraka's prescient 1971 essay *Technology and Ethos* as beginning a discourse about black vernacular technological creativity. Baraka called for people of African descent to rethink their relationships with technology and take action to make technology more representative of their culture. Baraka argued that through black technological utterances rooted within black cultures, communities, and existences technology would be more responsive to the realities of black life in Western societies [Baraka, 1971]. Baraka and other scholars and practitioners articulate the cultural nexus between art, Western technology, and its impact on the African cultural milieu [Anderson & Jennings, 2013].

“The technology itself must represent human striving. It must represent at each point the temporary perfection of the evolutionary man. And be obsolete only because nothing is ever perfect, the only constant is change [Baraka, 1971].”

According to Fouché, African Americans have had time to develop knowledge sets through the production of music, dance, literature, visual art, and sports. Fouché (2006:642) identifies this production in the following ways:

- Redeployment, or the “process by which the material and symbolic power of technology is reinterpreted but maintains its traditional use and physical form.”  
Example: African-American motorcycle engineers/builders customizing choppers.
- Reconception, or the “active redefinition of a technology that transgresses that technology’s designed function and dominant meaning.” Example: Artists engaging artifacts to make new art forms using DIY fabrication. [Fig. 7]
- Re-creation, or the redesign and production of a new material artifact after an existing form or function have been rejected. Example: DJs and turntablists developing new equipment and techniques.



Figure 7: Sonic architect Hank Shocklee and Beatrix Jar in Hacker Space at NAMAC 2012.

African American popular culture has renewed itself repeatedly through new technology, new audiences, improvisation, and continued borrowing [Manning, 2010]. Artists from underrepresented ECoPs combined different modes of black vernacular technological creativity with discipline-crossing and DIY methods. African American motorcycle engineers and builders Ben Hardy and Cliff Vaughns customized so-called “Billy” bikes, specifically for use in the seminal counter-culture film *Easy Rider* [Wasef, 2007]. Hardy and Vaughns remained largely unknown and uncredited for over two decades and, as African-Americans, were not welcomed into the mainstream white motorcycle world in the United States. Researchers (see Emdin, 2007; Wang & Huguley, 2012) contend that UEGs, whose cultural frames of reference may be oppositional to dominant ones, may have greater difficulty crossing cultural boundaries. However, researchers have yet to take the innovative practices and methods of underrepresented ethnic artists into account as legitimate forms of technology production. As a result, these methods are not counted as “technology” and are not taught in schools as forms of STEM. In fact, many of these practices, such as hip-hop, are viewed as being counter to educational objectives.

Scholarly analysis of African American creativity often center on the vernacular such as with the production and performance of music, dance, and literature [Snead, 1984; Hall, 1992; Fouché, 2006]. Rayvon Fouché (2006) presents his concept of black vernacular technological creativity to describe the ways African American people interact with material forms and effects of technology. As much as this study embraced the intent of his work it aimed to extend Fouché’s concept to describe the fundamental ways that African Americans and other underrepresented ethnic groups draw from and combine



diverse knowledge sets, artifacts, identities and practices. This research investigated the interrelationships between coexistent cultures and subcultures and how they relate to each other in mutually constructive ways. This includes the unpredictable, innovative rhythms in traditional African American quilts that are similar to those found in West African, Central African and Native American textiles and other art forms, such as jazz, breakdancing, and rap music [Walhman, 2001]. TVC modes of practice and technical production foregrounds the research of Fouché to identify, analyze and interpret how the conceptual and practical uses of vernacular art, crafts and technology can lead to improved STEM learning in underrepresented ethnic groups. [Fig. 8]

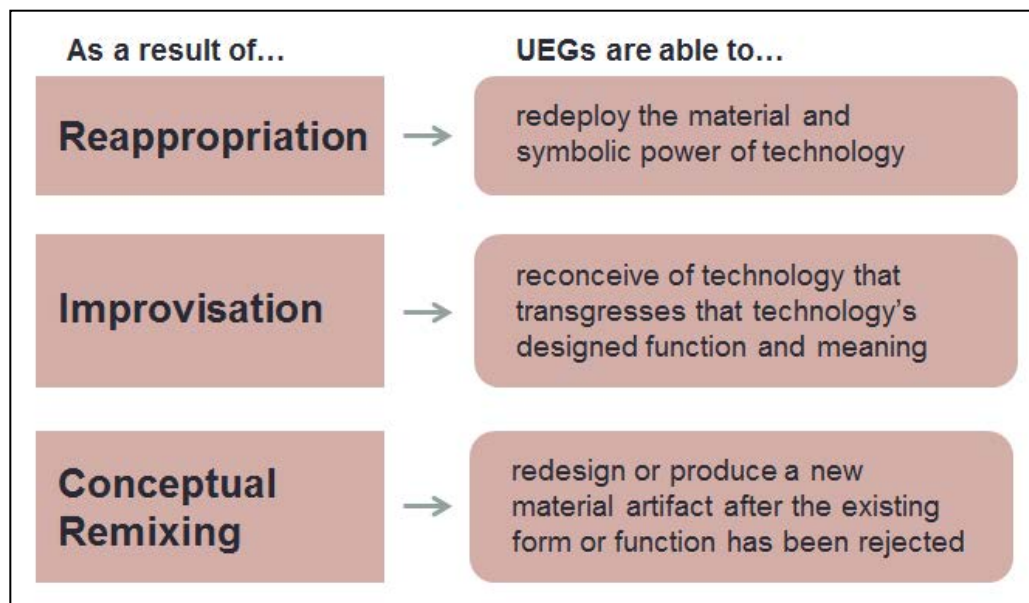


Figure 8: A framework for analysis and interpretation of TVC that builds on Fouché's work.

### 2.3. Vernacular Art, Crafts and Technology

A vernacular is the native language or dialect of a specific population (see Howell, 1688), as opposed to a language of wider, mainstream or dominant communication that is not native to the population. If something is described as being “in the vernacular,” it means that the thing being described possesses the characteristics

belonging to a specific language [Wardhaugh, 2006]. This communication or expression can be in the vernacular of 'the street' or describe a specific subculture. A visual vernacular is a look, style or expression that is associated with or native to a particular time, place, event or group. It characterizes symbols, images, or objects that come to mind when referring to any one of these specific things. Vernacular is a reference to zeitgeist, or cultural ethos that motivates the ideas and customs of a community of practice. Some scholars argue that rather than being native to a particular culture, hip-hop, for example, is the lingua franca (third language) of the world's youth [Morgan, 2013]. Dr. Morgan (2013) states,

“Hip hop is the imprint that symbolizes unity, justice and equality through its interpretation of black cultural and political practices and values. Its purpose is to reflect the perspectives of many followers of hip-hop (from across the globe).”

This study explores the vernacular/ lingua franca associated with artists and practitioners who use every day, common or cultural artifacts as technology, broadly defined, to create innovations such as improvisational quilts, graffiti, music, dance, games and software. It is when these forms come together as interconnected or interrelated texts that the domain of Techno-Vernacular Creativity (TVC) emerges. This study examines TVC, as part of a system of communication and creative expression that enables artists and practitioners to create work using the dynamic properties of different technologies. Artists use vernacular arts, crafts and technology to communicate messages, tell stories (see Hileman & Zorach, 2011) and create inventions. Their works straddle the boundary between art, craft and innovation. Their practices and processes are syncretic, often retained, repurposed or exchanged across many cultures and generations.

Syncretism (see Ascott, 2005) or the amalgamation of disparate knowledge sets is associated with representations and belief systems that reflect the myriad of African, Amerindian, European, Asian and North American cultures from which they emerged. Syncretism (see Claus & Mills, 2003), describes the “product of the large-scale imposition of one alien culture, religion, or body of practices over another that is already present.” This amalgamation or imposition has allowed for a rich mixture of associations between representations and a variety of techniques and media. Take, for example, circular imagery such as the traditional Mandala, a geometric diagram that represents the universe in Hindu and Buddhist symbolism. Depictions of the Tree of Life in Kabbalah, Whirling Dervishes, the shaman’s drum and stone Native American Medicine Wheels are but a few of many circular images found worldwide [Rudolph, 2010].

Artists of African descent use the Kongo cosmogram to draw on cultural ethos, contemporary technology, and artistic actuation in a self-determined, representational space [Deterville, 2012]. *Until the Quiet Comes*, a music video by African American director Kahlil Joseph, explores African cosmology and metaphysics. *Mandala of the Bodhisattva II* by artist Sanford Biggers and David Ellis makes visible the hip-hop ritual of the cypher, a figure that is also based on the naturally occurring circle, or mandala.

[Fig. 9]

“Each person’s turn in the ring was very brief-ten to thirty seconds-but packed with action and meaning. [...] Acrobatic transitions such as head spins, hand spins, shoulder spins, flips, and the swipe – a flip of the weight from hands to feet that also involves a twist in the body’s direction-served as bridges between the footwork and the freeze. The final element was the exit, a spring back to

verticality or a special movement that returned the dancer to the outside of the circle [Nelson George, 1985:90].”



Figure 9: Sanford Biggers, “Mandala of the B-Bodhisattva II,” 2000.

Biggers and Ellis re-purposed the traditional Hindu/Buddhist mandala and created a dynamic, representational space (breakdancing floor) for audience engagement and performance. The circular underlying pattern of the mandala is the foundation for improvisation. Artists such as Romare Bearden, Robert Pruitt, John Biggers and Sanford Biggers (a cousin of John) repurpose historical or traditional African American and American Indian quilts, using the visual patterns as a foundation for collage and painting.

Christian missionaries introduced quilting to young Native American women at boarding schools in the late 1800s [Edwards, 2010]. After leaving the mission, these women applied geometric patterns learned from beadwork and buffalo-hide designs to quilting, including an eight-point star, known as the Northern or Mathematical Star [Wulfert, 2004]. This Star Quilt design holds symbolic representations of life, spirituality,

and community for Native Americans. African American quilters and artists who use quilting as a way to communicate messages or stories has also used the Star Quilt design.

Vernacular art, crafts and technologies provide a general representation of the relationship between things in a given phenomenon and their cultural antecedents. Many methods and techniques used by African American artists and practitioners are examples of black vernacular technological creativity (Fouché, 2006), also referred to as “black technocultural syncretism” (Anderson & Jennings, 2014) and “techno-black cultural syncretism” (Rose, 1994), all of which describe dynamic relationships between cultural heritage and its re-contextualization through vernacular arts, crafts and technology. Scholars have provided a vocabulary to describe the aesthetic preferences of African-American quilters, which include asymmetry, bold and multiple patterning and improvisation [Wahlman, 2001; Bales, 2011].

Quilting, in addition to being an example of visual vernacular, is a conduit for storytelling. Harriet Powers, an African American woman who was born a slave in Georgia, created a visual vernacular of her own by using appliqué, a technique similar to collage, and quilting to communicate her unique visions and to tell stories. Powers’ quilts consisted of “pictorial squares” depicting biblical scenes and celestial phenomena [MFA Boston, 2014]. African American artist Sanford Biggers, a former graffiti writer and breakdancer or b-boy, uses appliqué, collage and spray paint to apply symbols and other materials to historical quilts (Cash 2011).

Quilting is an apt analogy for describing Techno-Vernacular Creativity because it requires some level of skill and technical knowledge often passed down from generation to generation by respected members (mentors) of a community of younger people

(apprentices) [Wahlman, 2001]. It requires some understanding of the vernacular of a specific ECoP and the capability of practitioners to communicate to an audience using symbols and designs. Folklorist Gladys-Marie Fry (1989) claims that quilts made by slaves of African descent in the United States were used to send messages. On the Underground Railroad, quilts with the color black were hung on the line to indicate a place of refuge (safe house)... “Triangles in quilt design signified prayer messages or prayer badge, a way of offering prayer. Colors were very important to slave quilt makers [Fry, 1989].” Artists such as Romare Bearden, John Biggers and Sanford Biggers repurpose quilts or quilt patterns to create their own visual vernacular. [Fig. 10]



Figure 10: Left: Romare Bearden, “Patchwork Quilt,” 1970, Right: Sanford Biggers, “Martyrs of the Race Course (inspired by Bearden), 2011,” 2011.

The idea that slave quilts were used as “sign posts” on the Underground Railroad is a point of contention among scholars [Brackman, 2006; Zegart, 2008; Gates, 2013]. Some argue that, in the circles of many traditional quilters, the key to the symbolism has been lost but others (see Wahlman, 2001; Fry, 1989) contend that the visual vernacular of Afro-traditional quilts have been passed on through generations. “If you ask them why they made certain decisions or included certain designs, they respond, ‘That’s just what my grandmother did [Wahlman, 2001].’” Scholars such as Maude Southwell Wahlman (2001) and John Michael Vlach (1976) study how artists and practitioners across the

African Diaspora preserve cultures and histories that with the impact of colonialism and slavery are in danger of disappearing.

Eglash & Bleeker (2001) note the “de-racializing” of cultural heritage in vernacular arts and crafts that particularly appropriate information technology, where cultural mixtures can “thrive, recombine, and mutate in ways unpredicted by static social codes.” Scholars (Eglash & Bleeker, 2001; Pollard, 1996:1-2) note how strategies of “subversion” employed by Africans across the diaspora created “cultural signposts, hope-filled intimations of a more just and humane world.” This de-racializing of cultural heritage occurs in the creative practices of underrepresented ECoPs who use vernacular technology to synthesize, syncretize and re-purpose arts/crafts.

Vernacular arts and crafts, based on local needs and materials, reflect local, cultural and historical traditions. Architecture is another technology adapted by practitioners who adapted Indigenous (Arawak), African and European styles of architecture to develop the shotgun style of building houses. Scholars (Davis, 2012; Fox, 2004; Vlach, 1976) study how vernacular technology, in the construction of shotgun houses, demonstrates the syncretic (eclectic) and hybrid nature of Indigenous and African diasporic cultures. Research indicates that this architectural style came to New Orleans from West Africa via Haiti. In Haiti, enslaved Africans “took the architectural form common to their homeland and using local materials, [...] wrote African motifs into the exterior framing of their homes. [GNOCDC, 2013]” Various themes and the cross-cultural collisions that resulted from these practices can be attributed to different innovations among ethnic groups such as African Americans, continental African, and



Indigenous people. As bell hooks notes how necessity begets ingenuity in the social rituals that domesticated rented (shotgun) houses and turned them into people's homes.

“As a structure, the shotgun house is a symbol of architecture created to express life lived in transition, life that is not fixed or static. It is the primal architecture of the displaced person, of one who lives a fugitive existence, always on the move. The shotgun house was for African-Americans a space of transition. One was not meant to live one's life in a shotgun house. It was a space in which one moved into to move on [hooks, 2000].”



Figure 11: John Biggers, “Shotguns (detail),” 1987.

John Biggers combined the syncretic; symbolic and visual design aspects of the shotgun style of architecture in his paintings. He treated the vernacular technology of shotguns iconically rather than naturalistically [Fox, 2004]. He frequently composed the fields of his paintings with repeated, flat, frontal gables from shotguns to imply the density and weight of African-American culture in the South. In *Shotguns*, a dense pattern of quilt swatches extends into an accumulation of shotgun gables, combining the



visual vernacular of traditional African American quilting with the vernacular technology of the shotgun house. [Fig. 11] Thompson (1995) calls attention to Biggers' iconic treatment of household items associated with everyday domestic life, reinforcing the representation of the shotgun as a symbol of collective dignity and cultural identity. Biggers remixed symbols and icons from the "visual gospel" (see Thompson, 1995:108) of everyday life, much like Romare Bearden did with collage, DJ Spooky did with D. W. Griffith's *Birth of a Nation*, and Grandmaster Flash did with the cross-fader on the DJ mixer—all innovations that inspire the ideas of underrepresented ethnic artists.

Making connections between art, culture and everyday life was a constant focus of John Biggers' creative practice that inspired future artists. Underrepresented ethnic artists often respond to the vernacular of diverse cultures in their artworks. Robert Pruitt, formerly an art student in a program founded by John Biggers, combines the North American Indian star quilt design with symbols from science fiction, science, continental African heritage, ethnography, comic books, and hip hop culture. Pruitt also founded Otabenga Jones and Associates, an artist collective that emphasizes the use of vernacular arts and crafts of architectural, spiritual and social significance [Klaasmeyer, 2013]. Different works by artists who bridge vernacular, art/crafts and technology were used to create tools, materials and workshop activities for this study.

## **2.4. Cultural and Social Practices**

Culture is a complex subject that includes the symbols, stories, rituals, tools, shared values, and norms of participation that people use to act, consider, communicate, assess, and understand both their daily lives and their images of the future [Brumann, 2002; 1999]. Cultural information reveals striking similarities and differences among

marginalized individuals and groups such as geography and the local environment, or the degree of assimilation in the dominant culture [Smith, 2012; Willis, 1978]. Most of these groups have some form of creative, material production and knowledge that produces artifacts [Winner, 1980; Bijker & Pinch, 1984; Fouché, 2006]. They engage in practices that give them agency to creatively select, develop, and transform aspects of their environment to create their own distinctive cultures [Willis 1978; Gell 1998; Emdin, 2010]. Each community has its own aesthetic, cultural data and production modes – its own type of vernacular. The concept of vernacular (see Smith, 2012:129) can be imagined in multiple ways such as physical, political, social, psychological, historical, linguistic, economic, cultural, and spiritual spaces. This study investigates the practices of artists from communities of practice that have been historically marginalized or underrepresented in mainstream dominant culture. These artists employ vernacular arts, crafts and technology in the creation of cultural artifacts (data) such as sculpture, paintings, virtual and physical avatars, graphics, sound, mobile media, games, stories, etc.

Culture emphasizes the social nature of learning, not only as a process of accumulating knowledge but rather as a process of becoming enculturated into a community of learners [Falk 2001] and practitioners. Individuals even within the same culture carry several layers of mental programming within themselves. Different layers of culture exist at different levels (e.g. cultural differences and social class) and differing levels of depth. [Fig. 12] Symbols, heroes and rituals are the tangible or visual aspects of cultural practices. In the diagram presented by Ifte Choudhury (2013) symbols represent the most superficial manifestation of culture and values the deepest, with heroes and rituals in between. Symbols carry a particular meaning that is only recognized by those

who share a particular culture. Symbols can be copied from one group to other groups but the meaning or use changes during the process of cultural exchange. For example, Sanford Biggers' *Mandala of the B-Bodhisattva II* makes visible the hip-hop cypher through the naturally occurring (universal) circle of the Buddhist mandala.

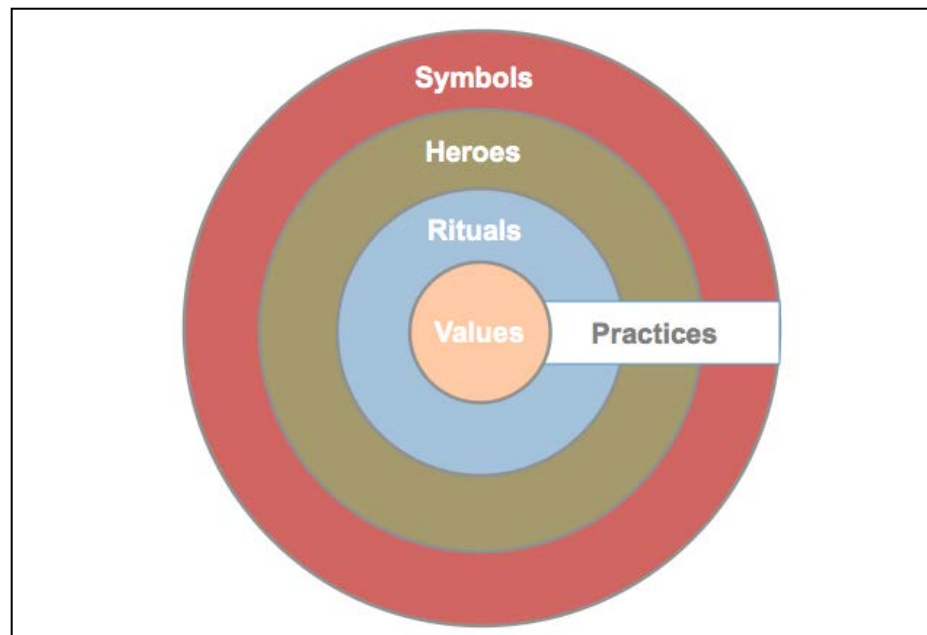


Figure 12: Manifestation of Culture chart by Ifte Choudhury, 2013.

Cultural competence means having an awareness of one's own cultural identity and views about difference, and the ability to learn and build on the varying cultural and social norms of ECoPs and UEGs [Martin & Vaughn, 2007]. Cultural competencies can be developed through story sharing, learning maps, symbols and images, and scaffolding [Yunkaporta, 2009; Gay, 2002]. [Fig. 131] Artifacts or artworks that are created in a specific location, within a certain culture or cultures are culturally situated. Elements of these works are often combined, recombined, remixed, collaged and assembled by artists to create new work. In *Blossom* (2007), a physical installation in which a sculpted tree grows through a player piano, Sanford Biggers tells a story using the tree to evoke the

symbolism attached to the subject of trees by different cultures, contributing to a “both/and” reading of the work [Biggers, 2012]. Biggers programmed the piano using a MIDI controller to perform his original arrangement of *Strange Fruit*.

In *Coded Narratives* (2013) Vanessa Ramos-Velasquez created a computer-based interface that corresponded with sound art and generated live via text input from the audience using an “emerging technological object of digital media and communication—the tablet—as narrative tool and conduit of art.” Like Biggers’ *Mandala* Ramos-Velasquez’s project engages audience members in a circle (e.g. campfire) similarly used in ‘call and response’ interactions or the cypher in hip-hop. These examples demonstrate multiple cultural (scientific and technological) competencies of artists from ECoPs (e.g. African diasporic, Indigenous) whose works can be used to scaffold or break up learning into bits and pieces, as a way to recombine, remix, collage or assemble new cultural images, narratives and identities. [Fig. 12]

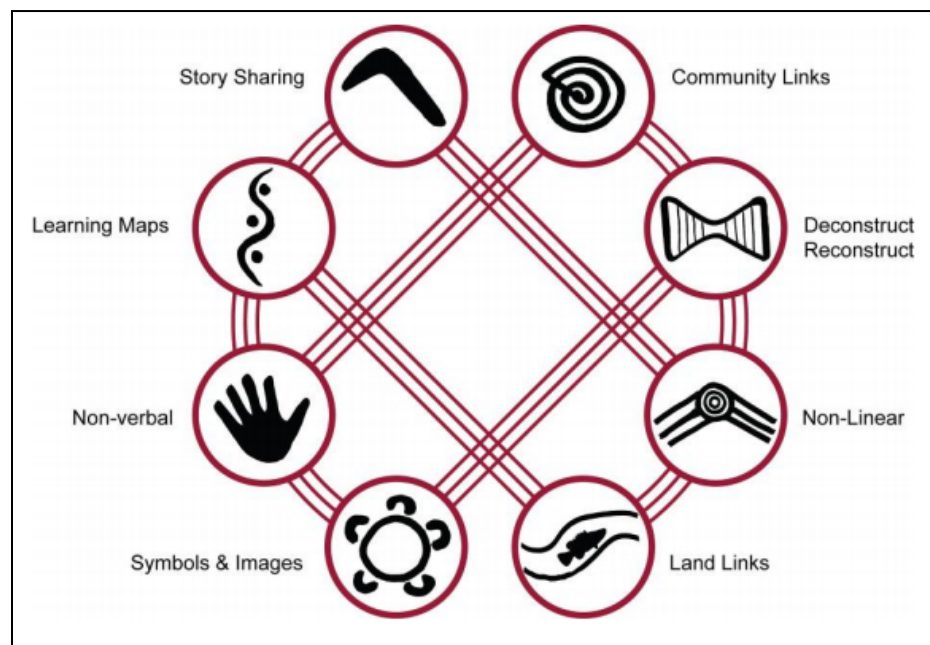


Figure 13: Indigenous Cultural Competence model developed by Tyson Yunkaporta.

The survival of culturally and historically marginalized ethnic communities is based on their ability to constantly reinvent themselves. Ethnic artists create work that often questions commonly held assumptions and stereotypes, self-awareness, portraiture, and what it means to be an individual in their work. Scholar W.E.B. Du Bois' (1903:898) definition of double consciousness or self-identifying, both with otherness and society can be compared and/or contrasted with de Certeau's (1984:25) *la perruque* ("the wig") that describes how members of marginalized communities code-switch from one identity to another [Sebba & Wooten, 1998; DeBose, 1992]. A different context is explained in poet Paul Laurence Dunbar's description of the mask that hides one's true self from its oppressor [Wiggins, 1992].

Artist Daniel Chandler (2011) writes that his ritual-art project, *MassQ*, is different from Dunbar's 'mask' mainly because its purpose is not to "conceal one's identity, or assume the identity of another, but to reveal the essence of the wearer in the moment it is created." These contexts can be used to explain the complex dynamics of Techno-Vernacular Creativity and are also supported by studies that illuminate the complexities of situated participation in cultural-historical contexts [Lave & Wenger, 1991; Hodges, 1998]. Members of historically marginalized communities often have multi-layered identities which incorporate each of the communities they have inherited. They also take from, share with, or exchange practices of different cultures. Thus, the term vernacular can represent any number of factors or representations.

W.E.B. Du Bois' notion of double consciousness plays a role in the symbolic construction or presentation of multiple cultural and social identities among UEGs. This phenomenon is made visible through the creative practices of underrepresented ethnic

artists. In his investigation of jazz improvisation, Daniel Oakland describes a “tradition/innovation paradox” in which “combinations of awesome, weird, and wonderful things (are) made up from scraps of old elements [Salamone, 1988:94]. The “opposing aesthetics” or “doubleness” of this paradox characterizes the heterogeneity of the African-American cultural experience which can also be used to metaphorically represent the social role of all underrepresented ethnic groups in dominant societies [Oakland, 1998:9].

For example, African American conceptual photographer Hank Willis Thomas, in collaboration with Sanford Biggers, examined themes of multiplicity, identity, and performance in his photographs. In the *Wayfarer* series (2013) Biggers, clad in a divided black and white suit, top hat, and dress shoes, strikes several poses that allude to “dandies,” vaudeville performers, dancers, and even Japanese Kabuki actors [Fig. 14]. Inspired by a portrait of a late-19th-century performer, the costume also refers to the Yoruba deity Elegba, the protector of travels and crossroads.



Figure 14. Hank Willis Thomas with Sanford Biggers. Photo shoot for ARTnews (2012). Photo (left) by Rebecca Robertson and (right) by Hank Willis Thomas.

Māori artist Robyn Kahukiwa also explores the theory of double consciousness – the feeling of being a member of an indigenous community and the dominant New Zealander culture. Her art fuses past and present to enact a desire to recover a simpler world of reciprocal responsibilities and social harmony [Eggleton, 2003]. Kahukiwa’s paintings *Hinetitama* and *Hine* celebrate Māori mythology and symbolism [Fig. 15]. In *Hinetitama* a Māori woman is shown becoming fragmented as she changes from an earth-dweller into a Goddess of Death. In *Hine* Kahukiwa incorporates geometric/cultural symbols with the feather cloak from Māori culture that is a sign of rank or respect. As in Chandler’s *MassQ*, the subject’s identity is masked or augmented with symbols from Māori mythology. Masking/augmenting reveals the multiple consciousness or identities of the artists or subjects. Symbols (designs) in the artwork communicate stories.



Figure 15. Robyn Kahukiwa. Left: “*Hinetitama*,” 1980, Right: “*Hine (Feather Cloak)*,” 2008.

Underrepresented ethnic groups are challenged to sustain traditional cultural knowledge while addressing the tensions that exist in the creative practices of today’s ethnic communities. Another challenge is what Fouché (2009) describes as the problematic of vision or the predicament of existing analysis and interpretation that

profoundly impacts the marginalized. This notion hinges on the idea that value, truth, purity, and legitimacy of marginalized individuals and communities are judged by the standards of dominant society [Du Bois, 1903]. Thus, those (artists) that fall outside of the dominant's criteria of what it means to be seen are not perceived as being as valuable, truthful, pure, or legitimate as the dominant because (these works) cannot be clearly detected through the interpretive viewing apparatus of the dominant [Fouché, 2009]. The next step in this development is to move from discourse to practice and, eventually, to critically challenge and alter the criteria by which the creative works of ethnic communities are judged.

Subsequent research and application of Fouché's theory and other theories that counter cultural and technological determinism offer guidance on ways to increase UEG interest and motivation in STEM and facilitate skill development. Fouché (2006:657) asserts that the technological experiences of creative UEGs need to be studied to "alter the current discourse of American (Western) technology" rather than to "multiculturalize our narrow understanding of technology." In order to develop more thoughtful analysis researchers need to think differently about questions asked and the tools practitioners and artists use to address this issue.

Techno-Vernacular Creativity often manifests in the ways in which people individualize culture, altering things, from utilitarian objects to maps to rituals, and language in order to make them their own. This has implications for how researchers assess techno-vernacular creative production modes, especially in how to assess the meaningful experiences that UEGs value. Michel de Certeau asserts that while social science possesses the ability to study the traditions, language, symbols, art and articles of



exchange that make up a culture, it lacks a formal means by which to examine the ways in which people reappropriate them in everyday situations [de Certeau, 1984].

A strategy frequently employed by artists from underrepresented ethnic communities is conceptual remixing (see Denzin & Lincoln, 2011:4) that produces a “pieced-together set of representations that is fitted to the specifics of a complex situation. This strategy connects to the creative practices of collage (e.g. Romare Bearden) and traditional African American quilting that combine symbols and artifacts from American Indian, African, and European cultures. .” Nelson & Tu (2001:8) point out that while access to technology remains one of the most pressing obstacles for UEGs, they overcome this challenge by appropriating and fashioning both content and technologies to fit their needs and priorities, creating a kind of technological conceptual remixing. In this way UEGs have become creators and innovators of new cultural and aesthetic forms that articulate their identities.

Technology, broadly defined, functions as an innovation or apparatus that enables art forms such as collage (remixing, sampling) and conceptual remixing with a variety of technological tools (examples are provided in the next section). Techno-vernacular creative production can give UEGs agency where social action takes place around and may be centered on creative practices and cultural information (artifacts, data). Thus, the concept of Techno-Vernacular Creativity calls for the legitimization of these practices as forms of cultural production.

## **2.5. Prior Work in Culturally Situated Arts-Based Learning**

### **2.5.1. Culturally Situated Design and Digital Media**

Constructivism is characterized by a set of principles relating to how knowledge is created and how individuals develop understanding. In this study, different methods were explored to integrate cultural art and design into STEM through constructivist learning and related theories [Charmaz, 2006; Duffy & Cunningham, 1996]. Socio-cultural theory, originating with the writings of Vygotsky (1978) emphasizes that learning is a form of enculturation, in which the individual is socialized through gradual participation in tasks, scaffolded or assisted by adults until full competence is attained. One interpretation of constructivism is situated cognition, based on the work of Lave (1988) who maintains that learning is best achieved when learning tasks are encountered, practiced and applied in real world contexts. Learning is situated and contextualized in action, everyday situations, as well as in diverse cultural and creative practices.

One key area of existing research to support this study is Culturally Situated Design Tools (CSDTs) [NSF 0634329] that have been used extensively to examine the relationship between culture and math education through student simulation tools, such as African textiles, the braiding of African-American cornrow hairstyles, Native American beadwork, graffiti art and afrofuturism (see p. 96). Research suggests that use of CSDTs can raise math achievement and may improve technological career aspirations for ethnic minority students [Eglash, et al. 2006]. While the outcome of this study is not higher academic achievement for UEGs, there is research to show that the use of mathematics and technology to create cultural designs can increase interest and motivation in STEM among UEGs. Eglash, et al. (2006) points to issues raised in the CSDT project such as

negotiating the representations of cultural knowledge during the design process with community members, negotiating pedagogical features with math teachers and their students, and reflecting on the software development itself as a cultural construction.

Learning sciences researchers are studying what young people are learning through computing and art. Researchers (see Kafai & Peppler, 2014) note that exploration of digital or “tangible” media texts seem especially promising in the domain of electronic textiles (e-textiles). While this research focuses mainly on DIY practices among youth this study looked at how these texts relate to culturally situated design. The use of vernacular art and crafts in the development of digital media supports TVC approaches to computational design such as conceptual, vernacular mapping and modeling that allow users to experiment or remix computational artifacts. This dissertation was a step in the direction of getting underrepresented ethnic learners to develop and explore technology and technological processes while creating their own design projects.

New technologies produced for the mobile web and with digital media have been shown to engage UEGs [Watkins, 2009; Zickuhr & Smith, 2012]. Researchers [Ito, Baumer et al., 2009] released groundbreaking research that documented a broad range of learner-defined modes of expression, online communication and participation using digital media, including games. Ito et al. (2009:67) defined three modes of engagement: “hanging out,” social engagement with digital media; “messaging around,” experimenting with creative production; and “geeking out,” the highest level of technological engagement. ILEs where young people hang out and mess around with digital media differ from what occurs in formal settings and are potential sites of participation and innovation [Ito 2009; Brown & Thomas, 2011]. Nelson & Tu (2001:8) note that technical

skills are gained through casual use of technologies and through networks of informal “apprenticeships,” where friends demonstrate to each other their techniques.

This dissertation investigates culturally situated arts based learning that builds on modes of Techno-Vernacular Creativity including the use of digital media. Drawing from the successes of projects like Glitch Game Testers (DiSalvo, 2009), Culturally Situated Design Tools (see Eglash et al., 2006), Barcode Beats (Björgvinsson et al., 2010), Do-It-Yourself technology (NSF 1224131), Game Design Through Mentoring and Collaboration (Sheridan, Clark & Williams, 2013), and robotics (Hamner, et al, 2008) this study merges research methods as a new approach to engage UEGs with a low rate of participation in STEM. The largest body of research with regard to diversity, access, and equity in the learning sciences focuses on gender, with specific attention to underrepresentation of women [NRC, 2009]. Studies that merge culture, creativity, and innovation among UEGs are less well considered. Only a few projects (for example Emdin, 2011; Magerko et al., 2013) have engaged artists and cultural practitioners from historically marginalized communities whose work integrates STEM concepts in ways that may be of interest to UEGs.

Based on this prior work, I collaborated with the CSDT community at Rensselaer Polytechnic Institute (RPI), with oversight from Dr. Ron Eglash, contemporary artists and cultural practitioners on the creation of web-based CSDTs that can be used to engage learners from UEGs in STEAM. Developed by RPI graduate student Libby Rodriguez, these new CSDTs allow users to apply mathematics skills to increase understanding of artwork provided by the artists that uses shapes, symmetry, and transformational geometry. CSDTs simulate the creative practices of artists by allowing users to import

their own shapes, then drag, drop and stack script blocks to create new designs. I developed pedagogy to support this development. This included culturally situated, arts-based instructional materials to be used by teachers as culturally responsive scaffolding activities [Gay, 2010] and workshops to engage youth from underrepresented ethnic groups.

Researchers (see Bennett & Eglash, 2013) use the term “design agency” to describe a loop in which an artist creates an artwork and designers create a tool that simulates this work. Then, users apply this simulation to create their own designs. This process supports experimentation and engagement with technology using informal and formal learning contexts. For this project, I worked with artists and software developers to identify artworks with designs that were amenable to computer modeling. This involved a two-way learning process and negotiation that took place on every level of production. This ‘design loop’ drove the process to develop culturally situated design tools (CSDTs) for this study that are described in Chapter 3.

One example of design agency is Sanford Biggers’ *Lotus*, a motif arranged in the shape of a blossoming lotus flower. Proximity to the image allows for a different type of investigation. Inside each petal shape is a repeating pattern of slave bodies lined in rows in the hold of a ship; an image reappropriated from a well-known anti-slavery poster. The original was a visualization of mathematical relation in the use of space in a typical slave ship. The 18<sup>th</sup> century image of this vessel was considered a form of computation that combines considerations of space, capital, and projected profit [Wood, 2000]. When creating *Lotus*, Biggers worked with assistants who used a variety of tools to enlarge,

repeat, and rotate the image. The design was replicated using a variety of technical processes such as glass etching, laser cutting and embroidery. [Fig. 16]

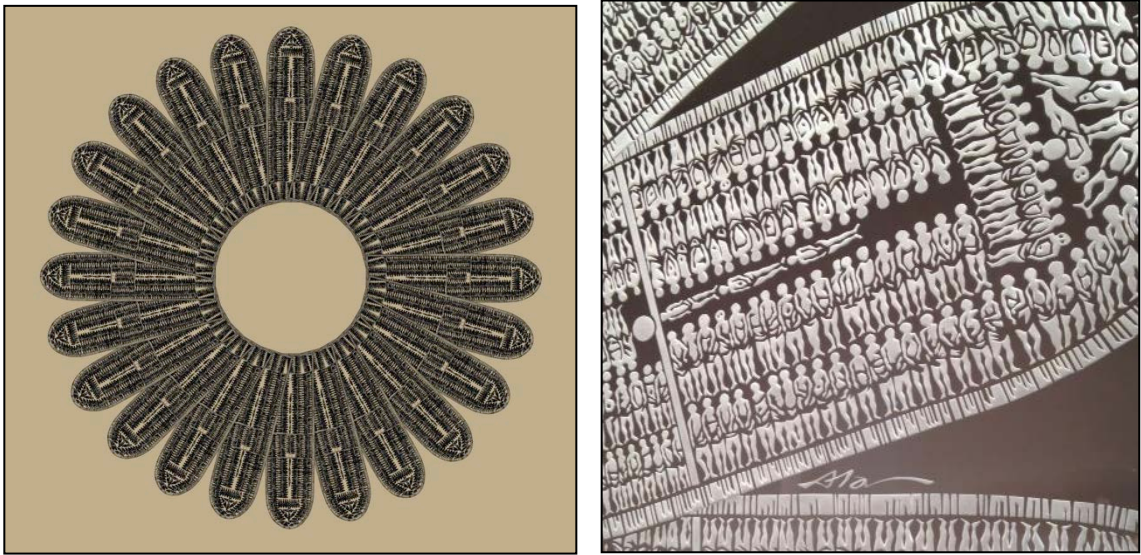


Figure 16: Sanford Biggers, “Lotus (screen print),” 2012 (right): “Lotus” detail etched in glass.

For the purposes of this study, a workshop was designed to present *Lotus* and other works as visual stimuli for activities that allowed participants to use different tools to apply specific techniques to create their own projects. The workshop afforded the target group with cultural knowledge, technical literacy and STEAM skills. Participants were encouraged to use this visual information and material to create designs using CSDTs. Participants had access to other applications and platforms such as the Romare Bearden Black Odyssey Remixes to create collages and a tangible multi-touch device.

### 2.5.3. Arts-Based Research

Arts-based research (ABR) is an emerging approach to qualitative research that brings together scholarly inquiry and creative processes. Arts-based research makes use of artistic processes and forms in one or more stages of the research process – as a topic of inquiry: inquiring into an art work (i.e., close-looking) or a creative process; or for

generating, interpreting or representing research. Researchers in various disciplines have found in the arts, be it theatre, film, painting, poetry, drawing, sculpture, photography, dance, music, digital arts, design, quilting, weaving, beadwork, or any other of the myriad of available art forms, appropriate methods for addressing the questions they are compelled to ask. For this project, I used ABR to develop pedagogy in relation to culturally situated design strategies and digital media production.

ABR emerged in the late 1970's through the work of researchers such as Elliot Eisner and Thomas Barone, who combined qualitative research with aesthetic concerns and the techniques of narrative fiction [Barone & Eisner, 2012]. ABR is an emerging set of methods that are very diverse, but united by their ambitions to blur the lines between social science and art. ABR provides an outlet for learners to express their knowledge and creativity by engaging all of the senses, thus allowing them to tap into their intrinsic learning styles [Eisner, 1994]. These methods tap into the artistic process as a primary mode of inquiry, creating various forms of art as a way to collect data, conduct analysis, and/or represent social science research [Leavy, 2009]. Other terms that cover similar ground include arts-influenced research, arts-based inquiry, scholARTistry (Siegesmund & Cahnmann, 2008), and A/R/Tography (Irwin, et al., 2004), the last of which adds the realm of education into the mix [Knowles, Promislow and Cole, 2010; Leavy, 2009].

Barone and Eisner (1997:95) apply two criteria to define arts-based research methods: the method should be engaged in for a purpose associated with artistic activity; the method is defined by the presence of specific aesthetic qualities, styles, or design elements that infuse the inquiry process and the research 'text.' The design elements employed in ABR vary according to the art form employed by the artist/researcher. The

approaches described by Barone and Eisner are primarily literature-based. In this study, ABR primarily takes the form of conceptual mapping. In addition to format, ABR design elements include visual vernacular used by non-experts and lay people, the physical realities evoked by the virtual world and the empathic understanding of its inhabitants [Barone & Eisner, 1997: 98]. Barone and Eisner (2012:170) highlight the potential of new technologies to further expand this area of study.

Barone & Eisner (1997:95) note that ABR is defined by the presence of “design elements that infuse the inquiry process and the research text.” Barone & Eisner (1997; 2011) note that arts-based educational research experiments with different methods to design a framework that employs contextual and vernacular rhetorical strategies to address conceptual learning. Arts-based research fosters collaborations between artists and practitioners in different professions such as computer software design. According to Shaun McNiff (2013), these efforts have emerged in the applied arts fields such as art therapy, education, and social science, or where the arts are used to serve communities. This strategy has not taken hold to the same degree in the fine arts. McNiff (2013:8) asserts that the people with the most to gain are often the most reluctant to participate.

To foster engagement and collaboration in this project, I invited artists Coco Fusco, Jacolby Satterwhite, and Saya Woolfalk to participate in a panel in conjunction with *The Shadows Took Shape* art exhibition at the Studio Museum in Harlem. *Enlightenment, Strange Mathematics & Rhythmic Equations* introduced artists and their works in relationship to STEAM learning. The discussion and supporting presentations explored topics such as fractal geometry, quantum physics and symmetry, and how artists are working with scientists and mathematicians to create tools that inform future projects.



Saya Woolfalk discussed her ongoing collaboration with ethnomathematician Ron Eglash (RPI).

“Since I was making a hybridization machine and I knew that I would be working with DJ Spooky as well, I decided that it would be great if he (Eglash) could take one of my images and fractalize it... and that became the pattern for the animation that you see on the vertical screen... it’s created by different algorithms and the algorithm is then transformed into an animation [Woolfalk, 2014].”

ABR researchers also cite earlier scholars who combined scientific and artistic sensibilities, such as W. E. B. Du Bois [Lawrence-Lightfoot, 2005]. Du Bois captured the interdisciplinary nature of portraiture through his analysis of double consciousness [Lawrence-Lightfoot, 2005:9].

“He (Du Bois) invented a way of being, a point of view, a style of work that quite naturally, dynamically, and organically integrated science, art, history and activism [Lawrence-Lightfoot, 2005:9-10].”

Sara Lawrence-Lightfoot developed a qualitative research methodology called social portraiture that bridges science and art and merges “the systematic and careful description of good ethnography with the evocative resonance of fine literature” [Lawrence-Lightfoot & Davis, 1997:4]. In its attention to both scientific and aesthetic concerns, social portraiture can be seen as an early innovation in modern Arts-Based Research [Cahnmann-Taylor, 2008]. This method employs several ABR approaches and two of them relate directly to this study. Social portraiture pays close attention to context as an important tool for interpreting meaning and “Portraitists” not only listen to stories,

but also do what Lawrence-Lightfoot calls “listening for a story,” a process of co-creating compelling narratives with participants complete with characters, metaphors, and a central narrative arc or theme [Lawrence-Lightfoot & Davis, 1997]. Portraitists can collect data in numerous ways, including in-depth interviews and observation. This project broadens this method by using close-looking (personal interpretation) with vernacular art, crafts and technology presented in informal learning workshops. Close-looking is a form of open-ended inquiry similar to Lawrence-Lightfoot’s listening for a story approach, allowing teachers or researchers to negotiate contextual information with group investigations of works of art [Hubard, 2007].

Many of the characteristics Lawrence-Lightfoot used to describe Du Bois can be used to describe the concept of identity integration, or the perceived compatibility of multiple social identities such as in Hank Willis Thomas’ *Wayfarer* photography series with Sanford Biggers. While Du Bois juxtaposed the African and European in describing the African American identity, today’s artists and cultural practitioners cross even more boundaries while also combining seemingly disparate ideas, symbols, and artifacts in an effort to find meaning, tell stories and evoke the physical realities of their worlds. Other scholars assert that Du Bois’ theory of dual, or multiple identity experiences can lead to subversive acts of resistance [Scott, Sheridan & Clark, 2014:14]. Artists from underrepresented ECoPs are active in selecting themes that can be used to perform and tell stories, strategically deciding on points of emphasis, and defining the arrangement or sequence of the story [Lawrence-Lightfoot, 2005:9-10]. Thus, ABR can be used to support the integration of diverse knowledge sets, artifacts, or identities in techno-vernacular creative production.

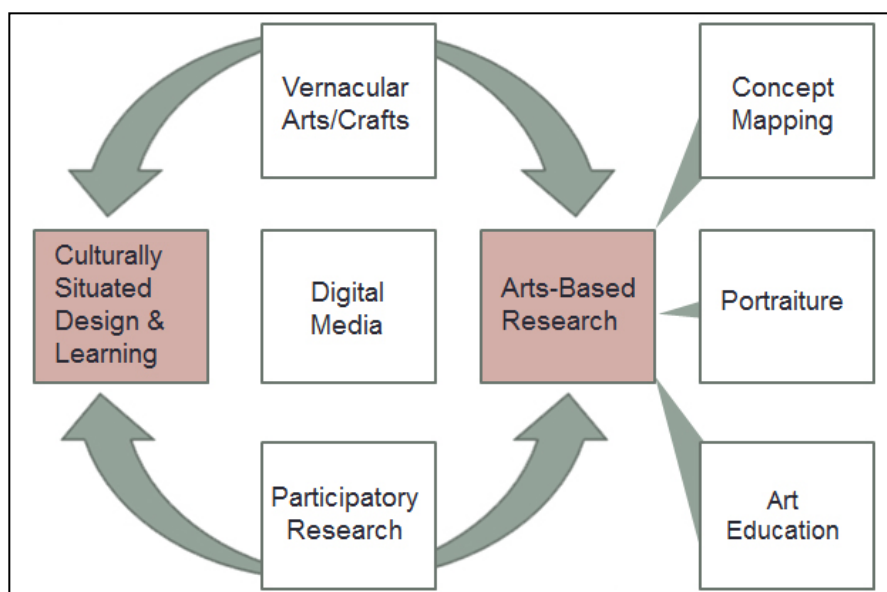


Figure 17: Prior work in culturally situated arts-based research.

Concept maps are another qualitative research methodology used in arts-based research to help people frame a project, analyze themes and interconnections in a study, and presents findings [Caña, Novak & Gonzalez, 2004]. A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions [Novak and Gowin, 1984:15]. [Fig. 17] Concept maps are created using broad themes or concepts, connecting them through linking artifacts (e.g. words, images, symbols) with other concepts or ideas. This strategy helps researchers focus on meaning [Cañas, Novak & Gonzalez, 2004].

Participatory research involves participants as co-researchers in all stages of the research process [Bergold & Thomas, 2012]. Participatory research is viewed as a means of producing knowledge as well as a tool for education, the raising of consciousness, mobilization for action and for the amplification of perspectives from the margins. Grounded in a participatory worldview, participatory research is concerned with developing practical knowing for human purposes with a focus on social action and

social justice. By bringing together action and reflection, theory and practice in participation with others, participatory research produces reflective knowledge, which helps people to name their world and so to change their world. This study applied participatory arts-based research in which participants were engaged directly in the creative process, allowing them to become co-authors, editors, and observers of the work [Dezeuze, 2010; Frieling, et al., 2008].

#### **2.5.4. Interest and Motivation Research**

Fostering interest has long been an objective in the learning sciences, as it is an outcome uniquely suited to informal learning activities [NRC, 2009]. A recent study measured students' "expressed interest," or what they say they're interested in learning, vs. their "measured interest," which was based on their responses to a series of questions designed to measure preferences for different types of "work tasks" [ACT, 2014]. Rather than merely positive emotions or momentary attraction, interest includes stored knowledge, stored value, and feelings that influence both immediate and long-term engagement, questioning behavior, and activity of individuals or groups of individuals around a specific topic. Interest always leads to motivated behavior [Renninger, 2007:5]. With motivation, participants begin to ask questions and seek answers as they engage with content [Renninger, 2007:2].

According to John Keller (2010:4) motivation explains what goals people choose to pursue and how actively or intensely they pursue them. All students, including diverse learners and those at risk for academic failure, can reportedly achieve more and are more likely to stay in school when they have a justification for learning [Fisk, 1999; NAM, 2003]. Students with no interest in science or related subjects have less capacity to attend,

find meaning, and identify their own questions in inquiry-based learning [Renninger, Bachrach, & Posey, 2008; Renninger, Ewen, & Lasher, 2002]. Keller (2010:45) suggests a design model that consists of four steps for promoting and sustaining motivation in the learning process: Attention, Relevance, Confidence, and Satisfaction (ARCS).

Attention can be gained in two ways: (1) Perceptual arousal or using surprise to gain interest or (2) Inquiry arousal or stimulating curiosity by posing challenging questions or problems to be solved [Keller, 2010]. Methods for grabbing the learners' attention include the use of active participation, variability or the use a variety of methods in presenting material (e.g. use of videos, short lectures, mini-discussion groups), specific examples such as visual stimuli and inquiry. Relevance increases a learner's motivation. To do this, this study used concrete language and examples with which the learners were familiar such remixing and collage. The relevance strategies described by Keller (2010) include experience or how the new learning will use learners' existing skills, future usefulness, modeling and choice or allowing learners to use different methods to pursue their work or allowing them to have a choice in how they organize it. Confidence helps learners understand their likelihood for success. According to Keller (2010), if learners feel they cannot meet the objectives or that the cost in time or effort is too high, their motivation will decrease. To build confidence, Keller suggests using scaffolding or using incremental steps to reach a goal, giving feedback, and allowing learner control. For satisfaction learning must be rewarding, whether from a sense of achievement or for entertainment.

Learning is not confined to school. Many underrepresented ethnic artists are part of large communities that function as educational learning systems for producing,

preserving, and transmitting artistic, cultural and social knowledge [Oakland, 1998:10]. Artists or students learn their craft by “hanging out,” “messing around,” and “sitting in” (see Oakland, 1998) or “geeking out” (see Ito, 2009). Informal learning (see Falk & Dierking, 2000) challenges students to use the knowledge from their own cultures and communities to connect and extend their learning. This study employed motivational design to foster interest in underrepresented learners, by combining TVC and STEAM in informal learning activities and settings.

## **2.6. TVC Learning Taxonomy**

Techno-Vernacular Creativity describes a capacity to *contextualize* or place something in a new or different context, *synthesize* or see relationships between seemingly unrelated fields, and *syncretize* or invent something new by combining elements nobody else thought to put together [Pink, 2005:130]. Underrepresented ethnic artists employ a variety of techniques to attain specific technical skills and learning capacities. After identifying artworks that demonstrate TVC, I developed a learning taxonomy to distinguish fundamental questions and issues regarding different capacities for engaging UEGs in STEAM. [Fig. 18] The TVC taxonomy refers to classifications of different learning objectives that describe techno-cultural production in underrepresented ethnic communities of practice. A purpose of these classifications is to understand the relationships between the TVC modes of practice that foster engagement, questioning behavior (interest), and motivation of the target group with STEAM concepts.

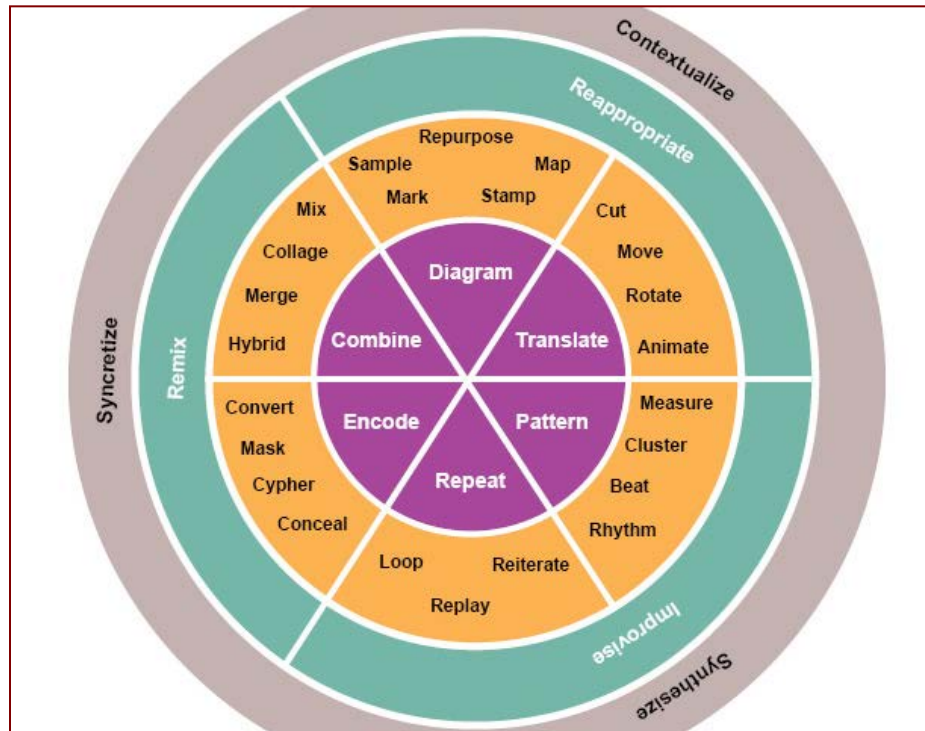


Figure 18: TVC taxonomy and learning objectives.

The following is a brief introduction to the diverse works that illustrate how underrepresented ethnic artists employ STEAM through TVC and building on Fouché's principles of Redeployment, Reconception and Re-creation:

### Contextualization and Redeployment



Zimbabwean-born artist Nontsikelelo Mutiti uses translation and diagramming as a starting point for her artworks. Mutiti redeploys Western symbols, hair braiding motifs and other cultural artifacts to produce new patterns.



Artist Hank Willis Thomas who reappropriates and redeploys heritage artifacts and advertising. Thomas uses the qualities of diagramming and translation in creation of multimedia installations that merge cultural symbols with archival footage.



Pamela Phatsimo Sunstrum who is interested in the connection between Africa and the cosmos redeploys adinkra symbols. Sunstrum uses translation and diagramming to create drawings and multimedia installations.

## Synthesization and Reconception



Artist Ellen Gallagher who is interested in the ocean's depths and ecologies. Her *Osedax* installation consists of 16mm film, painted slide projections, animations and sounds that layered to create patterns and loops. This work also combines different types of media to simulate ocean microclimates.



Hip-hop pioneer Grandmaster Flash who played a key role in the technical design of Rane Corporation's Empath mixer. His invention, the cross-fader, replays songs from two or more sound sources that are plugged into the device.



Sound architect Young Guru who contributed thousands of digital loops and beats to the EarSketch program. The program combines computing principles and musical patterns through collaborative computational music composition and remixing.

## Syncretization and Re-creation



Chilean artist Guillermo Bert who uses software and industrial processes to diagram and encode the stories, poems, and narratives of influential leaders of indigenous communities using QR codes, which are then embedded into tapestry patterns recreated by weavers from those communities.



Brazilian artist Vanessa Ramos-Velasquez uses electronic music, the Internet and tablet PCs as a part of her performances. In *Coded Narratives* Ramos-Velasquez collaborated with British Jamaican electronic musician A Guy Called Gerald on a project articulated through Morse Code and sound art generated live via text input from the audience.



Hip-hop artist Yung Jake who raps about tweet culture, datamoshing, hashtags, and memes in his HTML5 music video, *E.m-bed.de/d*. He performs online and pops out of walls, magazines and mobile devices in his online music videos. His multimedia project combines new media and performance by encoding images with digital information.



These works interweave techno-vernacular creative production with STEAM concepts and informal learning contexts (see section 2.7) through their content, methodology, and technological implementation. Details about how the artworks were used in culturally situated arts-based learning projects are in Chapter 3 (Methods).

## **2.7. Informal Learning Contexts**

“Education, whether formal or informal, is a major part of becoming assimilated into any culture... [Oakland, 1998:10].”

Techno-Vernacular Creativity emphasizes the social nature of learning, not only as a process of accumulating technical skills but rather as a process of becoming enculturated into a community of learners (see Falk, 2001) and a community of practitioners (see Wenger, 1998). Technological fluency needs to go beyond content knowledge or skills to include a “sense of seeing yourself as someone who is a creator and as someone who can collaborate with other people to produce something” [Barron via Eberbach & Bernstein]. To address the design of creative learning cultures Barron (2006:195) illustrates a “learning ecology,” or “set of contexts found in different settings that provide opportunities for learning.” In this scenario, learners are active in structuring and extending their own learning and using their discretionary time to engage in their interests. In this section, I argue that culturally responsive and contextual learning reinforces a learning ecology for Techno-Vernacular Creativity that takes place in artists’ studios and installations, museum exhibitions, and in communities of practice.

Researchers emphasize a need to develop a more in-depth understanding of culture if we want to bring about true understanding among diverse populations [Wilson-

Portuondo, 2008]. Lee's (2009) Cultural Modeling Design Framework suggests how informal learning can be more culturally responsive. Using specific strategies this framework's design principles—prior knowledge, cultural ways of knowing, engagement and motivation, social and civic empowerment—closely relate to other contextual learning models. This approach acknowledges, responds to, and celebrates full, equitable access to education for students from all cultures [The Education Alliance, 2006]. Culturally responsive pedagogy recognizes the importance of including students' cultural references in all aspects of learning [Gay, 2002; Ladson-Billings, 1994]. Alternatively, culturally responsive pedagogy seeks to perpetuate and foster linguistic, literate, and cultural pluralism to support equity in diverse groups and learning settings [Paris, 2012].

In education, Piaget described constructivism as being a process whereby students construct their own systems of knowing. Constructionism (see Harel & Papert, 1991) expands on this in terms of helping students produce constructions that others can see and critique. In this educational frame, then, constructivism is more cognitive and constructionism more physical. The three cornerstones for constructionism in learning environments include context, construction, and collaboration [Jonassen & Land, 2000]. Milrad (2002) expanded on this set to include elements that can be enhanced with technology including authentic activities, reflection, situating the context, and multi-modal interaction. Self-assessment becomes part of the learning process so that students play a larger role in judging their own progress. This study designed a learning workshop that combined constructionist and culturally responsive teaching strategies with contextual learning models that were placed in the wider context of cultural influences and interactions, including heritage, tools, and language [Vosniadou, 1996].

These strategies and models are important developments for informal learning environments or ILEs (see National Research Council, 2009; Falk J. H., 2005; Rennie, Feher, Dierking, & Falk, 2003), especially programs that reach out to or attract underrepresented ethnic groups. Studies show that learning is taking place in ILEs (NRC, 2009). Hofstein and Rosenfeld (1996:90) adopt a hybrid definition of informal learning as proposed by Crane, Nicholson and Chen (1994):

“Informal learning refers to activities that occur outside the school setting, are not developed primarily for school use, are not developed to be part of an ongoing school curriculum, and are characterized by voluntary as opposed to mandatory participation as part of a credited school experience. Informal learning experiences may be structured to meet a stated set of objectives and may influence attitudes, convey information, and/or change behavior.”

The term “free-choice” learning describes the type of informal learning that occurs most frequently outside of school; in particular, free-choice learning refers to the type of learning typically facilitated by museums, science centers, a wide range of community-based organizations, print and digital media [Falk & Dierking, 1992; 2000]. Researchers describe free-choice learning as follows: “[Free-choice learning is] the term we use to describe the learning that occurs in ... education settings when the learning is largely under the choice and control of the learner ...” [Falk, Heimlich, & Foutz, 2009:5]. Choice within the formal setting has been a topic of motivational research. Katz and Assor (2007) used a self-determination theory (SDT) [Ryan & Deci, 2000] lens to determine under what conditions choice motivates and when it does not. Their conclusion was that:

“In order for choice to be motivating, it has to be based on a careful match between the various options and the students’ needs, interests, goals, abilities, and cultural background. In addition, considerable attention should be paid to the context and manner in which the choice is provided.”

For this study, I referred to a Contextual Model of Learning [Falk & Dierking, 2000] that includes the following contexts to build on characteristics of expressed interest among learners as requisite for personal motivation (see Fig. 19):

- Personal Context - Learning is facilitated when participants’ expectations are fulfilled by displays of works of art or other items of interest. This includes relating personal interest and ‘new’ knowledge from a foundation of prior experience and knowledge.
- Sociocultural Context - Learning is both an individual and group experience. We recognize that all communications such as exhibitions, TV, Internet, and so on represent a socially mediated form of culturally specific communication between the producers of the medium and the user. In this context, it is important to provide access to a variety of new media types and platforms.
- Physical Context - Learning is situated, or bound to the environment in which it occurs. Creating personal connections and interactions in a museum or recreation space enhances the motivation and expectations of learners. Also, learning is always diverse in a free-choice context because people have different learning agendas and purposes and emotion is a vital aspect of learning and problem solving.

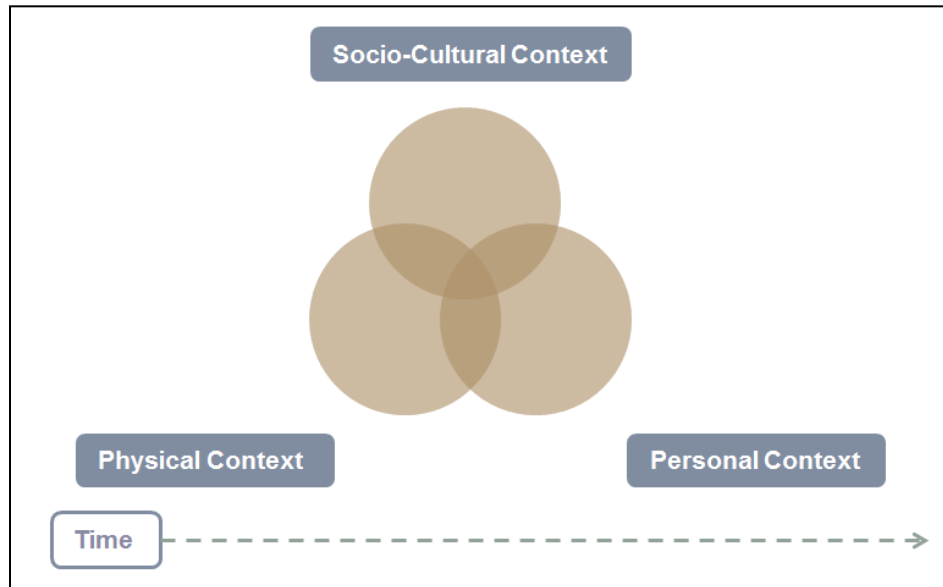


Figure 19: Contextual model of learning as proposed by Falk & Dierking (2000)

Falk (2001) asserts that traditional methods of framing research on learning are flawed. Rather than asking what individual learners learn as a consequence of an educational experience, he suggests that researchers ask how multiple sources of an experience contribute to an individual's understanding. By using or modifying existing methods and materials with UEGs in an informal learning setting and through engagement with TVC modes of practice, this study responds to Falk's challenge.

Understanding the potency of a TVC learning ecology for informal STEAM learning, this project investigated different contextual learning models and methods by designing a workshop to provide the target group with access to different places, tools, and learning opportunities that allowed them to experiment with creative activities and that are consistent with their interests. Workshop activities combined TVC modes of practice and taxonomy with Keller's (2010) Instructional Materials Motivational Model or IMMS (see Chapter 3) to assess levels of interest and intrinsic motivation.



Figure 20: Left: Sanford Biggers, “Quilt #13,” 2012; Right: Bernard Williams, “Mural,” 2012.

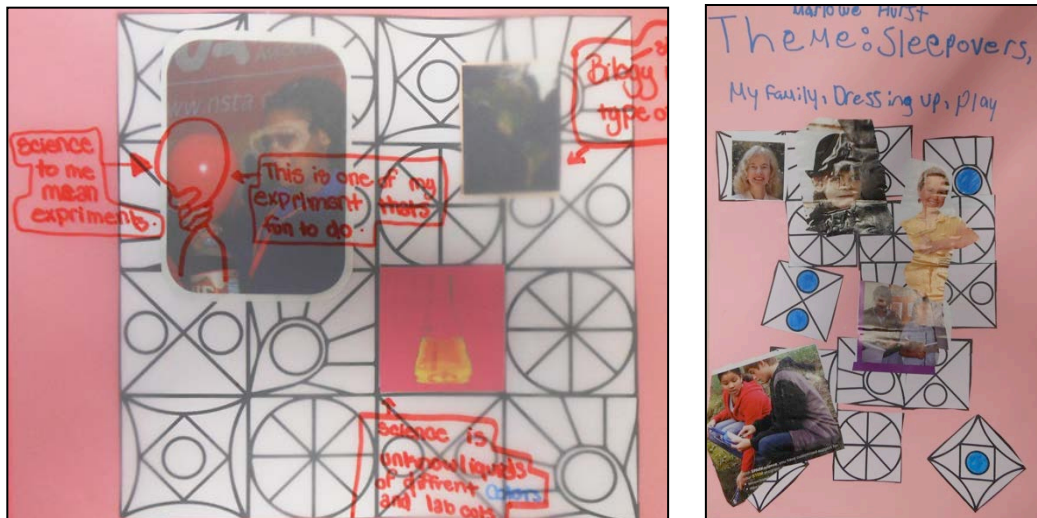


Figure 21: Drew Charter School 4<sup>th</sup> grade vision map projects.

Underrepresented ethnic learners explored STEAM learning tools and applications that took issues of culture and art into account, to build their technical skills and cultural competency. Workshop activities included creating diagrams or maps that repeated, remixed and combined visual motifs to produce new patterns; using computer-based tools to simulate vernacular artwork such as quilts that engaged concepts such as geometry. [Fig. 20-21]

## **CHAPTER 3: TVC IN RESEARCH AND PRACTICE**

### **3.1. Overview**

Vernacular art, like any other form of communication and social organization, is a culturally specific response to particular environmental conditions. Technology extends the creative and symbolic dimensions of cultural art forms. Techniques such as repetition have both physical and digital equivalents. Techno-Vernacular Creativity or TVC engages these methods through modes of practice such as reappropriation, improvisation and conceptual remixing that are supported by critical theories such as Rayvon Fouché's black vernacular technological creativity, culturally situated design and concepts such as augmenting, algorithmic modeling and fractals. TVC practices described in this chapter can be applied to the acquisition of STEAM and the intrinsically motivated engagement with technology. This research project looked at how underrepresented ethnic artists contextualize, syncretize and synthesize cultural information through the production of vernacular art, crafts and technology. TVC frames a variety of projects and artwork toward addressing goals particular to informal and formal STEAM education:

- a) Provides a culturally responsive approach to informal learning, combining culturally situated design strategies and arts-based research as a means for engaging UEGs in STEAM;
- b) Increases UEG interest and intrinsic motivation in STEAM learning experiences;
- c) Brings A and B together to diminish the separation between TVC and STEM;
- d) Addresses, not only cultural and social issues, but also satisfies the pedagogical demands of curricula [Eglash, et al, 2008].

The goals of this study are framed in relation to the problem identified in Chapter 1 (section 2). This chapter addresses the persistent decrease in UEGs' opportunities to enter STEAM disciplines in relation to the increase in UEG postsecondary engagement with vernacular art, crafts and a narrowing of the digital divide. This chapter highlights a variety of techno-cultural engagements that are employed by underrepresented ethnic artists by combining specific tools, techniques, technologies and knowledge and social/cultural relationships. This production includes methods that cross many artistic forms such as repetition, the augmenting or layering of images and space, and the TVC modes of practice that commonly use these techniques.

Repetition in African American creative expression is most prevalent in performance such as rhythm in music, dance and language [Snead, 1984:68]. The organizing force that produces this aesthetic is rhythm or the ongoing recurrence of a beat. Repetitive words and multiple, conflicting rhythms are important elements of African performance and its American descendants – gospel/spirituals, blues, and jazz. Although most often discussed in music the rhythm and polyrhythm aesthetic can also be found in visual art, crafts such as quilting and technology. [Fig. 22] Sophie Sanders (2013) asserts that the syncopated rhythms and call-and-response structures in art are culturally ingrained, functioning as organizing principles across all aspects of black cultural production. This includes aesthetic qualities of rhythmic pattern or the 'cut,' as James Snead (1984) called the black cultural insistence on repetition (e.g. music, collage).

“Polyrhythms are where the magic is conjured. Odd versus even, dynamics and accents, it's all language,” he says. On occasion, he even layers conflicting



rhythms on top of one another to create more complicated patterns [Afrikan Sciences via Derek Opperman, 2013].”

Snead (1984:69) defines the ‘cut’ as an “abrupt, seemingly unmotivated break in a (sequence) already in progress.” Beth Coleman (2009:202) calls this break a “disruption of syntax,” similar to the twentieth century Italian Futurists who attempted to destroy Western icons and replace them with altered systems. The ‘cut’ also insists on the repetitive nature of a sequence. For example, in jazz improvisation, the ‘cut’ is the unexpectedness with which the soloist will depart from the theme [Snead, 1984:69]. This unexpectedness or disruption characterizes the aesthetic production of traditional African American quilters who use repetition and rhythm [Bales, 2011]. Artworks with specific designs/patterns are amenable to algorithmic modeling, sampling, and remixing using computer-based software. Scholars have found evidence of fractal geometry in quilts (see Bales, 2011) and artifacts such as Lukasa memory boards that display fractal scaling (see Eglash, 1999:166) and geometric designs (see Roberts and Roberts 1996:132).

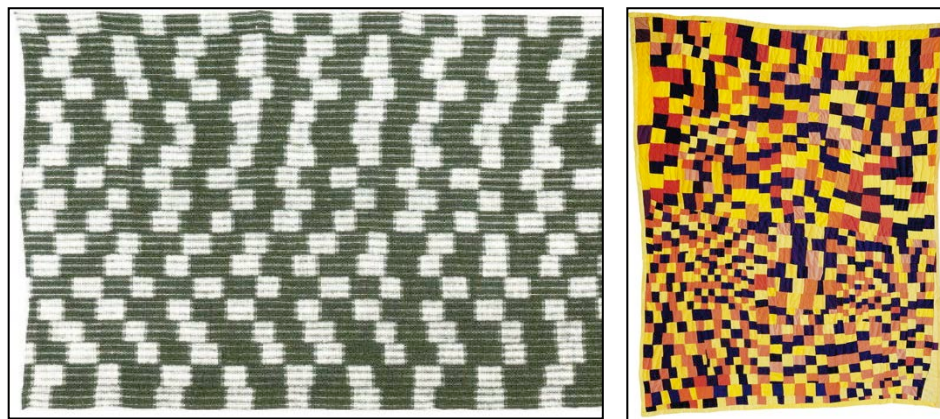


Figure 22: Left: Hausa Cloth, Nigeria. Courtesy Eli Leon, Right: “Three Sixes,” 1996-97. Pieced by Rosie Lee Tompkins, Richmond, California, 1987. Quilted by Willia Ette Graham and Johnnie Wade, Oakland, California, 1996.

Scholars across disciplines make reference to repetition or polyrhythm, either through sound or in visual patterns. According to Patrick Manning (2010), black culture “renews itself repeatedly through new technology, new audiences, improvisation, and continued borrowing.” Coleman (2009:178) extends the function of *techné*—technique or technical skill— to race as a collision of value systems. In her view, race exists as if it was “on par with a hammer or a mechanical instrument; denaturing it from its historical roots” and freely engaged as a productive tool.

Repetition, through techniques such as repurposing, sampling and remixing, employ the ‘cut’ through disruption—transformation through language and signification—that enables artists across the African Diaspora to piece together the fragments of their past that resulted from historical emigration (e.g. forced relocation), violence and marginalization. Ellen Gallagher cuts shapes from paper and repeats drawn shapes in her work. [Fig. 23] Kara Walker reclaims black 18<sup>th</sup> and 19<sup>th</sup> century silhouettes as a narrative device to give graphic recognition to chattel slavery in the United States, and the vestiges of Jim Crow in contemporary society. Walker often layers these shapes over wall projections and in stop motion animations. [Fig. 24] Wangechi Mutu pieces together magazine imagery with painted surfaces and found materials to explore the split nature of cultural identity. [Fig. 25]



Figure 23: Ellen Gallagher, "Osedax," (2010).



Figure 24: Kara Walker, "Darkytown Rebellion," 2001.



Figure 25: Wangechi Mutu, "Non je ne regrette rien," (2007).

Wangechi Mutu uses the term ‘augment’ to describe her process of altering and layering or superimposing disparate images in her collages [Enright, 2008]. The process Mutu describes can be used to describe augmented reality (AR) technology that superimposes computer-generated images on a user's view of the world, thus providing a composite view. [Fig. 26]



Figure 26: Re+Public. “RETNA mural augment,” 2012. Art Basel Miami.

The augmenting technique that is employed in collage is extended digitally through augmented reality. Vernacular artwork can be simulated or layered in AR applications such as *Re+Public*, a mobile application that uses AR technology to alter the expectations of urban media and reimagines public space. *Re+Public* developers collaborated with Los-Angeles-based artist Marquis Lewis who goes by the street name of RETNA. [Fig. 26] Augmented reality technology works by creating and displaying text or images on physical objects that trigger applications on mobile devices such as iPads. In effect, the composite AR image on the mobile screen is a digital collage. More artists, museum and gallery professionals are using AR and other barcode-based technology to enhance physical artwork.

## **3.2. Techno-Vernacular Creativity Modes of Practice**

### **3.2.1. Cultural Reappropriation and Re-Purposing**

Researchers (see Galinsky, et al, 2003) define reappropriation as “the phenomenon whereby a stigmatized group revalues an externally imposed negative label by self-consciously referring to itself in terms of that label.” This allows a less dominant culture or subculture to re-appropriate elements of the dominant (Western) culture, re-signify them, and effectively re-localize what has been made global by appropriation. Reappropriation extends to counter-hegemonic re-purposing or borrowing of images, symbols and sounds from mainstream (dominant) culture. Jazz music was the result of a well-established pattern of reappropriation and adaptation; African and Latino Americans routinely assimilated elements of dominant culture by accepting its forms while drastically altering its content [Ludigkeit, 2011:172] such as: African and Native Americans altered the European style of quilting, Chicanos modified automobiles, rap producers and DJs remixed existing sounds. Musicians and quilters infused dominant conventions with African stylistic elements and rearranged existing material in new ways.

“Creating a form that would later be appropriated by American advertising and utilized by other American artists, quilters wove textual and visual elements together, thereby solidifying a powerful pictorial form of public meaning-making [Hillard, 1994:118].”

Artists reclaim symbols such as Jim Crow-era advertisements (e.g. the coon grin) or images from historical texts (e.g. slave ship, quilts) and artifacts for mobile technology such as QR (matrix) barcodes or codes/images that trigger augmented reality (AR) content. In African and Native American communities quilts are used as communication



or storytelling devices. Sanford Biggers re-purposes historical quilts, and then applies cultural artifacts, QR codes, and geometry to them. [Figs. 27-28] One motif used by Biggers is an eight-point star, known as the Northern (Morning, Bethlehem, or Mathematical) Star. Christian missionaries introduced quilting to Native American tribes from the Great Plains who applied geometric patterns learned from buffalo-hide designs to quilting [Edwards, 2010]. In most of his repurposed quilts Biggers attaches *Lotus*, a motif created by rotating and repeating the shape of a slave ship to form a flower that symbolizes beauty and enlightenment in Buddhist/Hinduism. Through reappropriation, repurposing and the repetition of common symbols (shapes) Biggers creates his own personal narratives to signify cultural expression, communication and technology.



Figure 27: Left: Star Quilt from [nativeamericanstarquilts.net](http://nativeamericanstarquilts.net); Right: Sanford Biggers. "Quilt #30, Nimbus (with star quilt)," 2013.



Figure 28: Sanford Biggers, Left: “Vex (with Lotus and QR code),” 2013, Right: Detail with QR code.

The use of quilts as textual sites is particularly evident in traditional African American (Afro-traditional) quilting. Many symbols in Afro-traditional quilts represent a secret language from African culture [Wahlman, 2001]. However, the key to this symbolism has largely been lost in the United States. In order to preserve the narratives and artifacts of their culture, contemporary Indigenous artists use barcode technology. Chilean American artist Guillermo Bert’s *Encoded Textiles* creates hand-woven, large-scale tapestries that combine contemporary bar codes, indigenous design methods, the stories of native peoples. Navajo artist Will Wilson (2012) uses the QR code as a “dynamic, trans-customary portal” embedded a Diné textile as precursor to the computer and as a storytelling device. In addition to reclaiming cultural artifacts artists such as Rammellzee, RETNA (Marquis Lewis) and Esteban Patino embed personal languages of symbols with messages only known to themselves and their communities. [Fig. 29]



Figure 29: Left: Esteban Patino, “Possible Structure for a New Language,” 2009;  
Right: RETNA’s trademark language in a painting.

In media production such as visual art, textile design and music, sampling is defined as the act of taking a portion from one source and reusing it to create a new project. Hip hop music was the first popular music genre based on the art of sampling—being born from 1970s DJs who experimented with manipulating vinyl on two turntables and an audio mixer [Lott, 2013]. The sample is a discreet unit of information (i.e., a sound, shape, or motif) that can be repeated to create a pattern. Harlem NYC-based hip-hop fashion designer Dapper Dan (Daniel Day) sampled luxury logos and “Africanized” them by creating patterns that simulated patterns in custom leisure suits from central Africa and Liberia [Sanneh, 2013]. Dan was inspired by Kuba textiles that are composed by breaking the expected continuum of surface, by staggering and suspending the pattern [Thompson, 1974]. These patterns are also math-based (see Bales, 2011). [Fig. 30]





Figure 30: Left: Dapper Dan Sneaker Freaker cover, December 2012, Right: Kuba textile (detail).

Underrepresented ethnic artists and designers reappropriate systems and symbols from dominant culture, often using technology to communicate messages in a variety of formats; they use their creative practice to subvert existing systems in order to create new ones. It is through the use of a shared vernacular that culturally relevant themes and narratives emerge. Reappropriation gives artists agency to repurpose dominant metanarratives of historical meaning, experience and knowledge. Their works combine popular art forms with techniques such as collage, STEM concepts such as geometry, spirituality and scientific folklore to invent new identities, languages and worlds.

### 3.2.2. Improvisation and Collaborative Expression

Improvisation elicits the active engagement or participation of diverse, ethnic communities of practice. Jazz music improvisation is a pivotal structural device created

by stylistic forms that foreground certain aesthetic qualities and narratives. In her novel, *Jazz*, Toni Morrison recognized the aesthetic tradition of African American art forms such as jazz as an important part of the cultural framework that shaped her own creativity [Ludigkeit, 2001:165]. Morrison makes conscious use of this framework by translating specific characteristics into printed text such as rhythm, improvisation, audience participation. Like Morrison, artists and crafts people translate aspects of this structure into works that are different from its European counterparts. [Figs. 31-32]

“African American quilters often adopt what we think of as traditional Euro-American quilt patterns and ‘African Americanize’ them by establishing a pattern in one square and varying it in size, arrangement, and color in successive squares. [Wahlman, 2001].”



Figure 31: Josie Covington, “Album Quilt,” 1895.



Figure 32: Nora Ezell, “Star Quilt (fractal design),” 1977.

Repetition in African Diasporan creative expression is most prevalent in performance such as rhythm in music, dance and language [Snead, 1984]. The organizing force that produces this aesthetic is rhythm or the ongoing recurrence of a beat. Repetitive images, words and multiple, conflicting rhythms are important elements of African vernacular and its American descendants – gospel, spirituals, blues, and jazz [Foster, 2002; Smitherman, 1977]. Although most often discussed in music this vernacular can also be found in vernacular art and crafts. African American artists deliberately fracture or disrupt typical rhythms and patterns to create new arrangements. The aesthetic quality and mode of production employed by these artists is improvisation, through repetition, the ‘cut,’ and *call and response*, a pervasive pattern of participation



that includes the spontaneous verbal and non-verbal interaction between speaker and listener(s) in which the statements (“calls”) are emphasized by expressions (“responses”) from the listener(s) [Smitherman, 1977]. Riffs, vamps, and thematic variations are prevalent in improvisation and repetition (see Snead, 1984) and linked to African American quilting (see Wahlman, 2001; Bales, 2011), collage and painting (see O’Meally, 2008; Alexander, 2004).

Neuroscientists have also investigated ‘call and response’ practices. A Johns Hopkins study looked at the neuroscience of jazz, hip-hop/rap and improvisation [Castillo, 2011; Limb & Braun, 2008]. What the researcher(s) found is that the brains of musicians and rappers who are engaged with others in spontaneous improvisation show robust activation in the same brain areas traditionally associated with spoken language and syntax. In other words, improvisational conversations take root in the brain as a language. In her 2014 lecture at the High Museum of Art, Julie Mehretu claimed “speaking before thinking” or improvisation as an important part of the cultural framework that has shaped her own creative practice. Toni Morrison explores African diasporic stylistic elements such collective improvisation that includes controlled or spontaneous feedback, artist/audience participation and immersion in the printed text [Ludigkeit, 2001:174].

Like jazz musicians artists also play along with music to hone their own improvisation skills. Romare Bearden studied art, science, mathematics, and education and successfully turned his hand to composing jazz music. John Biggers was inspired by jazz music (see McNally, 1996) and mathematics and incorporated Afro-traditional quilt patterns (Wahlman, 2001) in his murals. Biggers’ works are steeped in African themes,

symbolism and structures such as polyrhythm or multiple, unpredictable rhythms played/displayed at the same time. Sherri Lynn Wood's *Improv Handbook for Modern Quilters* explores improvisation in contemporary quilting. Wood's uses the concept of the (musical) score to outline projects rather than providing step-by-step instructions.

“The 10 patchwork projects featured in the book are organized as ‘scores’ or ‘games’ rather than as patterns. A score or lead sheet, common to improvised musical traditions such as jazz, is a set of notations or parameters within which the improvisation is free to take shape [Wood, 2014].”

Artist/musician Sanford Biggers borrowed and elaborated on John Biggers' 1987 mural *The Quilting Party* that represents an integration of knowledge from many academic disciplines. In this work, African mythology and folklore are fused with mathematical concepts (see Eglash, 2006), scientific theories, literary extracts, American historical events, sociological patterns and religious beliefs. [Fig. 33] Sanford Biggers' *The Cartographer's Conundrum* engages this knowledge to create new work [Cash, 2011]. Sanford Biggers used call and response to involve elements of *The Quilting Party*, as if in conversation with the creator of the mural: he added something, substituted elements from the mural with new ones and re-arranged specific elements. Thus, understanding the characteristics of improvisation is critical to deciphering the complex layers presented in John Biggers' mural and Sanford Biggers' translation. [Fig. 34]



Figure 33: John Biggers. “The Quilting Party,” 1984-1987.



Figure 34: Sanford Biggers. “The Cartographer’s Conundrum,” 2012.  
Note “The Quilting Party” mural by John Biggers is featured in this installation.

Mnemonics or learning tools play an important role in improvisation. Mnemonic devices “organize and encode information to make (music, stories) more memorable [Roberts & Roberts, 1996:29].” Instruments and tools (e.g. boards, tablets, DJ mixers) allow artists to remix sounds and images/patterns that are mapped out in particular positions on the devices and as visual images of abstract designs whose (elements) represent different themes or meanings [Berliner, 1994:72]. Overlapping (layered) memories can vary slightly in detail from person to person but they also form a sense of shared history that builds community [Oakland, 1998:13].

Daniel Oakland (1998:12) also uses mnemonics to describe informal learning that takes place in underrepresented ethnic communities of practice. Lukasa memory boards are hand-held wooden objects that present a conceptual map of fundamental aspects of the culture of the Luba people, the largest ethnic group in the Democratic Republic of the Congo. Lukasa boards teach people about cultural symbols, heroes, rituals, values and other aspects that construct the history of a culture [Roberts & Roberts, 1996:37]. [Fig. 35] The Lukasa maps memories using incisions and beadwork to indicate significant places, people, events or ideas. Lukasa are a means of communication and a tool for improvisation for the Luba people.

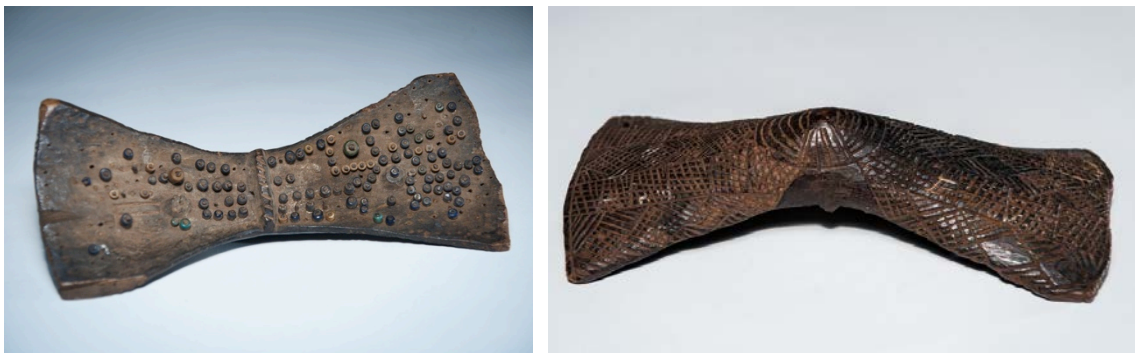


Figure 35: 19<sup>th</sup> century Lukasa (front, back). Courtesy of Royal Museum for Central Africa.

Improvisation, as a key mode of Techno-Vernacular Creativity, engages underrepresented ethnic artists and their audiences in new works. Collaborative expression through improvisation can be applied to a range of informal and formal activities and settings to engage UEGs in STEAM.

### **3.2.3. Conceptual Remixing and Bricolage**

Conceptual remixing, broadly defined, means to fiddle, tinker and by extension make creative and resourceful use of whatever materials are at hand, building by trial and error. In this study, I exchanged the term bricolage [Lévi-Strauss, 1962] with conceptual

remixing to counter the view that UEGs use only simplistic technologies—remixing requires sophistication and a mastery of materials. Conceptual remixing combines remixing – taking samples from pre-existing materials to combine them into new forms—and the “refunctioning, by societal ‘outsiders,’ of symbols associated with the dominant culture [Dery, 1993.] This process results in the ability to put together the pieces and to invent something new by combining elements nobody else thought to pair [Pink, 2005]. For example, Ghanaian sculptor El Anatsui combines nsibidi and uli ideographs, adinkra block symbols, and recycled aluminum liquor-bottle tops to create tapestries. [Fig. 36]

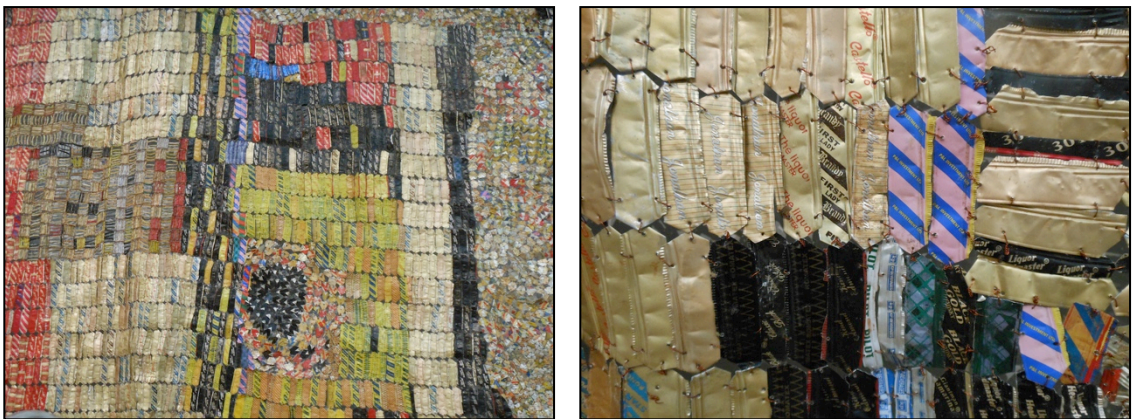


Figure 36: El Anatsui. “Earth’s Skin (details),” 2007.

“I believe that artists are better off working with whatever their environment throws up. I think that’s what has been happening in Africa for a long time, in fact not only in Africa but the whole world [El Anatsui via Gerald Houghton, 2003].”

Conceptual remixing extends to other expressions and inventions, including in visual art, music and performance (e.g. jazz, hip-hop); it plays a vital role in mass communication, especially in electronics and on the Internet. The best example of this is in African American music. DJs isolated short drum breaks or “breakbeats” from existing songs, then repeated and extended these breaks for longer durations [Broughton &



Brewster, 1999]. DJs manipulated or remixed sounds using turntables and audio (DJ) mixers. Remixing applies to turntablism and scratching, a process developed by early hip-hop DJs such as Grand Wizard Theodore and Kool Herc. Scratching produces distinctive sounds by moving a vinyl record back and forth on a turntable while optionally manipulating the crossfader on a DJ mixer. What is important about this is that DJs not only reappropriated the turntable but they reinventing its core functionality, transforming its core function from consumption to production.

“A phonograph in the hands of a ‘hip hop/scratch’ artist who plays a record like an electronic washboard with a phonographic needle as a plectrum, produces sounds which are unique and not reproduced—the record player becomes a musical instrument [Oswald, 2004].”

Hip-hop's pioneers—the DJs, MCs, dancers, artists, and their communities—“imposed their creative will” on mainstream society with minimal resources [Watkins, 2005:28]. Grandmaster Flash, one of the pioneers of hip-hop DJing, cutting, and mixing, paved the way for the next generation of DJs such as Filipino turntablists DJ Babu (Melvin Babu) and DJ QBERT (Richard Quitevis), and Sierra Leonean inventor DJ Focus (Kelvin Doe). Artist and hip-hop pioneer Rammellzee employed technological conceptual remixing through the collision of styles and forms of expression and by altering instruments and systems. [Fig. 37]

“The B-boy bricolage bodied forth in Rammellzee’s ‘bulletproof arsenal,’ with its dangling, fetish-like doll heads and its Computator cobbled together from screws and wires, speaks to dreams of coherence in a fractured world, and to the alchemy

of poverty that transmutes sneakers into high style, turntables into musical instruments, and spray-painted tableaux on subway cars into hit-and-run art [Dery, 1994].”



Figure 37: RAMMELLZEE, “Gash-olear (b-boy conceptual remixing),” 1989-1998.

A contemporary equivalent to this production are Do It Yourself (DIY) maker spaces that are characterized as informal, networked and peer-led, and promoting shared learning. Maker culture has attracted the interest of educators concerned about students’ disengagement from STEM subjects. Maker culture is seen as having the potential to contribute to a more participatory approach and create new pathways into topics that will make them more alive and relevant to learners [Sharples, et al., 2013]. While this seems like a promising movement for UEG engagement, maker or hacker spaces have also been known to exclude underrepresented ethnic practitioners [Grenzfurthner, Friesinger & Schneider, 2013]. On the other hand, techno-vernacular conceptual remixing comes from

the experiences of historically marginalized, under-resourced UEGs in oppressive or adverse environmental conditions. Conceptual remixing grows out of these experiences.

Innovation is often defined as the recombination of existing ideas and knowledge to create a new idea that is useful and practical [Ancona & Caldwell, 1987]. The creative processes of recombination and identity integration may account for innovation at the individual level. Individual differences in how multiple social identities are integrated may influence a person's ability to recombine knowledge systems and materials that, in turn, can predict how well and the extent to which a person can come up with innovative ideas [Sanchez-Burks, Chen & Lee, 2007]. Thus, the modes of Techno-Vernacular Creativity – reappropriation, improvisation and conceptual remixing – are historically embedded in cultures where individuals, often by necessity, integrate multiple social identities and practices. This type of integral awareness supports innovation in groups that are underrepresented in STEAM. One or more modes of Techno-Vernacular Creativity often work together, as demonstrated by the use of vernacular art in the development of web and mobile-based software described in the following sections.

### **3.3. TVC Across the STEAM Disciplines**

STEAM is an interdisciplinary learning method where rigorous academic concepts are coupled with artistic works and cultural practices as students apply Science, Technology, Engineering, Art and Mathematics in contexts that make connections between school, community, personal interests, and the global marketplace [RISD, 2014]. Elements of STEAM include:

- **Science**, which deals with and seeks the understanding of the natural world [NRC, 1996, p. 24], is the underpinning of technology. Scientific processes include “inquiry,” “discovering what is,” “exploring,” and using “the scientific method.”
- **Technology** is the modification of the natural world to meet human wants and needs [ITEA/ITEEA, 2000/2002/2007, p. 7]. It includes computer software learning tools, networking systems and protocols, hand-held digital devices, digital cameras, and other technology, including those not yet developed, for accessing, creating, and communicating information.
- **Engineering** is the area in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind” [ABET, 2002].
- **Art** is the creative expression or application of skills and imagination through forms based on culture, personal style, and technique. Forms range from the cultural arts, drawing, painting, sculpture, design, music, and video [NAEA, 1994, p. 32].
- **Mathematics** is the science of patterns and relationships [AAAS, 1993, p. 23]. It provides an exact language for technology, science, art, and engineering.

The STEM to STEAM movement is gaining momentum in the United States and abroad [Krigman, 2014; Devaney 2013]. Prior to this study, there has been a substantial effort by the National Science Foundation (NSF) and other funders to integrate informal STEM learning and arts-based learning to foster innovation [NSF 0943769, 1224111, 1224131]. The goal of this funded research was to advance understanding of the potential

impacts of creative thinking methods on the public's understanding of and engagement with STEM, with a focus on 21st century workforce skills of youth and adults [Seifter, 2012].

While STEAM projects have met considerable success in supporting youth to engage in STEM areas most of these studies did not take cultural factors into account (Kafai & Peppler, 2014; DiSalvo, 2009; NSF 1224131; Hamner, et al., 2008). This was the impetus for conducting *Advancing STEM Through Culturally Situated Arts-Based Learning*, a two-day NSF-sponsored workshop at Georgia Tech that investigated the roles that culture and the arts play among UEGs. As a part of this study, the workshop aimed to engage a dialog among researchers, educators and TVC practitioners whose work engages STEAM concepts to add the dimension of culture to STEAM initiatives.

Linking vernacular arts, crafts and technology to STEM is an important step to building a framework to support culturally situated design (see Eglash, 2006) and culturally responsive learning (see Gay, 2002; Ladson-Billings, 1994). Underrepresented ethnic artists use scientific and mathematical principles in the creation of their work. The geometric forms and themes of life, the universe and environment that are explored by artists from underrepresented ethnic communities such as Fred Eversley, John Coltrane and John Biggers can be used to inform or educate learners from UEGs. Eversley creates sculptures that operate according to the optical principles of physics. [Fig. 38] For *Giant Steps*, jazz musician John Coltrane created a mnemonic device and circular diagram or mandala to represent Einstein's Theory of Relativity. Physicist and musician Stephon Alexander (2013) describes how this diagram plots out geometrical theories of quantum gravity and matches the notes and chord changes in the song.

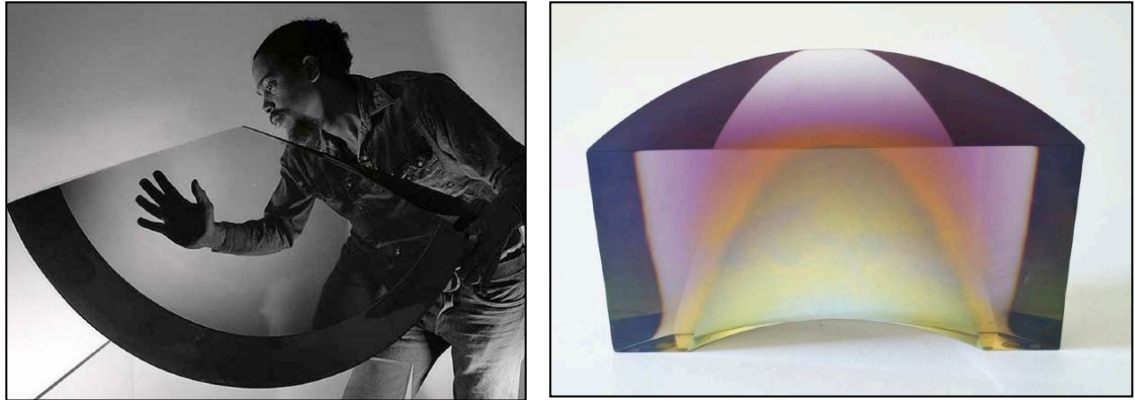


Figure 38: Fred Eversley, Left: “Energy (studio photo),” 1970, Right: “Multicolor Lenses series,” 1969.

The use of traditional or historical quilt patterns and the geometric shapes used by John Biggers in paintings like *Shotguns* and *The Quilting Party*, demonstrate STEAM concepts such as ethnomathematics or the study of culture with the presentation of math (see Eglash, 2004) and ethnoastronomy which investigates culture and celestial objects such as stars (see Urama & Holbrook, 2009).

Studies of the cultural aspects of science, mathematics and other academic fields extend existing research in STEM, as well as in contemporary art in underrepresented ethnic communities. Ethnomathematician Ron Eglash has developed tools for analyzing visual elements and designs in ethnic folk practices, such as African American cornrowing and Native American weaving, as well as artwork such as John Biggers to create awareness of the process through which cultural knowledge progresses and to design culturally situated design tools (CSDTs).

“The art of John Biggers [...] visualize(s) the fecundity of his African heritage, geometry’s universal truths, and cold precision stand in stark contrast to our expectations of cultural specificity and organic roots. Much of the genius in

Biggers late work depends on his ability to smoothly blend these conceptual opposites [Eglash, 2004b].”

John Biggers’ artwork incorporating celestial forms (e.g. stars and planets) is also an example of ethnoastronomy, a field that focuses on the many ways that people and cultures interact with celestial bodies. Jarita Holbrook – among the first African American women to earn a doctorate in astrophysics – explored the origin state of the universe revealed in African creation myths [Holbrook, 2008].

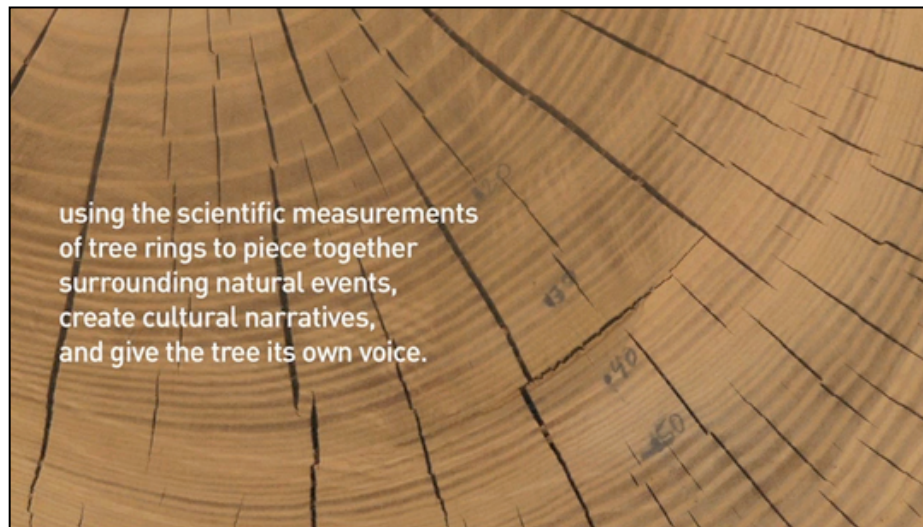


Figure 39: Vanessa Ramos-Velasquez, “360°,” 2014.

Saya Woolfalk, one of several artists who worked with the CSDT community at RPI to develop culturally situated design tool (CSDT), explores scientific folklore where biology and anthropology inform fables of utopia [Hays, 2013]. Woolfalk, Sanford Biggers and other artists participated in workshops, interviews and presentations I conducted in different locations such as studios and museums. There are details about this collaboration in section 2.5. For her project *360°*, Brazilian artist Vanessa Ramos-Velasquez worked with dendrochronologists to study tree rings that are used as source

materials to build cultural narratives. [Fig. 39] During a professional workshop that was conducted for this study, Ramos-Velasquez (2014) stated,

“In this process of my research I became interested in examining different narrative structures and I’ve always been interested in indigenous culture because it is so different than Western culture. Their narrative is circular. The sounds and the structures of the oral history (are) circular. The concept of time is circular. They do not obey a linear construction and in working with nature I wanted to create a measuring instrument that would relate to these concepts.”

Researchers and artists (Sunstrum, 2013; Gates, 2010; Eglash & Bleeker, 2001) explore how specific cultural representations relate to STEM subjects. The Hindu/Buddhist Mandala, North American Indian Medicine wheel, and West African cosmogram can be linked to transformational geometry [Eglash, et al., 2006]. West African adinkras have been linked to supersymmetry in particle physics (see Gates, 2010). The visualizations of African music (polyrhythms) are linked to strip cloth weavings in African textiles (see Thompson, 1983:207). The latter patterns are also seen in traditional African American quilts (see Wahlman, 2001). These tangible, visual and polycultural aspects of vernacular arts/crafts and technology are very important in understanding and analyzing techno-vernacular creative production.

Cultural scaffolding is a situated approach that recognizes that culture plays an active role in enabling communication and learning, both from within a culture and across cultures [Gay, 2002]. Artists from underrepresented ethnic groups engage in projects that explore vernacular art/crafts, using STEM concepts. Their collaborations



serve as inspiration for the design of a STEAM model to employ culturally situated arts based learning in a variety of educational settings such as schools and museums. This study ‘quilts’ together existing methods, practices and articles of exchange produced by artists from underrepresented ECoPs to support the creation of culturally situated art-based learning strategies.

### **3.4. Techno-Vernacular Creativity and Mapping**

A map is defined as a diagrammatic representation of an area or a concept. This study used Techno-Vernacular Creativity to explore the concept of maps and mapping in a variety of contexts and platforms, from conceptual and cultural maps such as mandalas, quilts and Lukasa personal memory boards to mobile augmented reality murals and tangible multi-touch surfaces. Diagramming— representing ideas in graphic form—is an important TVC characteristic that uses techniques such as remixing. Diagrams can be used to trigger digital content in mobile augmented reality (AR) applications and on multi-touch surfaces with tangible markers that identify a location or element in a two or three-dimensional space.

The diagramming of motifs, shapes and other objects show the formal possibilities of geometric variation. Participants in this study explored diagramming based on vernacular or vision mapping. [Fig. 39] Each square in a vision map design uses a different motif and these motifs were repeated. This type of mapping project foregrounds *computer vision frameworks* that use black and white squares in varying patterns to make detection by a camera-enabled device happen quicker. [Fig. 40]

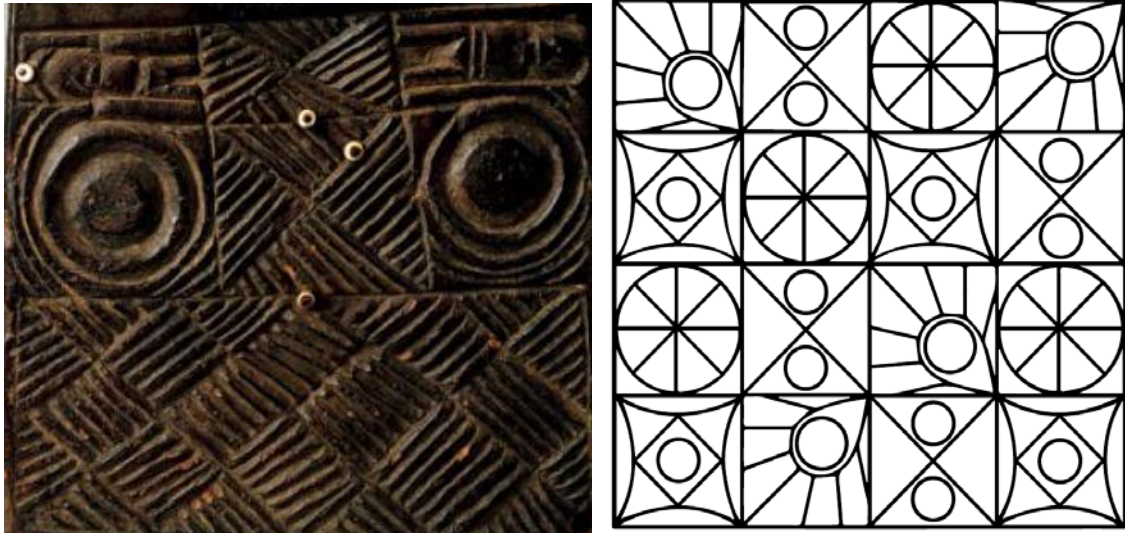


Figure 40: Left: Lukasa memory board (detail), Right: Vision map template.

In order to produce vernacular maps or diagrams, artists translate and rotate shapes to create different patterns. This process is similar to an artist that remixes an original artwork by creating something completely different or the jazz musician or DJ who combines fragments of various works to create a new composition. To extend this process, I provided study participants with access to computer-based tools such as:

- Mobile augmented reality (AR) with fiducial markers placed in the field of view of an imaging system which appears in a physical mural, for use as a point of reference or a measure [Fig. 41]
- Multimedia authoring tools such as culturally situated design tools that remix mandalas using computer programming and math (see section 3.5)
- Tangible multi-touch surfaces that track fiducial markers and gestures [Fig. 42]

CSDTs were developed through collaboration and others such as the AR platform and multi-touch digital Lukasa were created prior to the study and used by study participants during workshops.

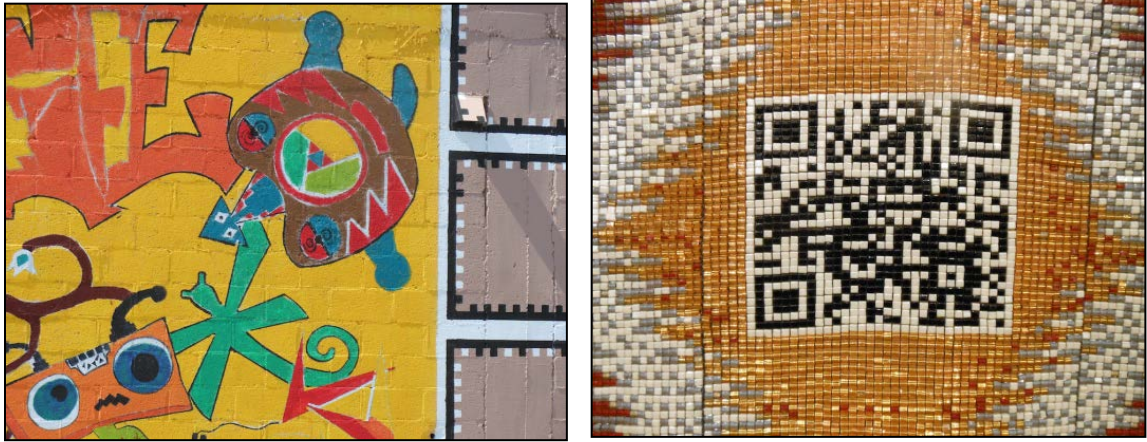


Figure 41: Left: AR mural for ISEA2012 (detail with markers), Right Will Wilson, “eyeDazzler,” 2012.

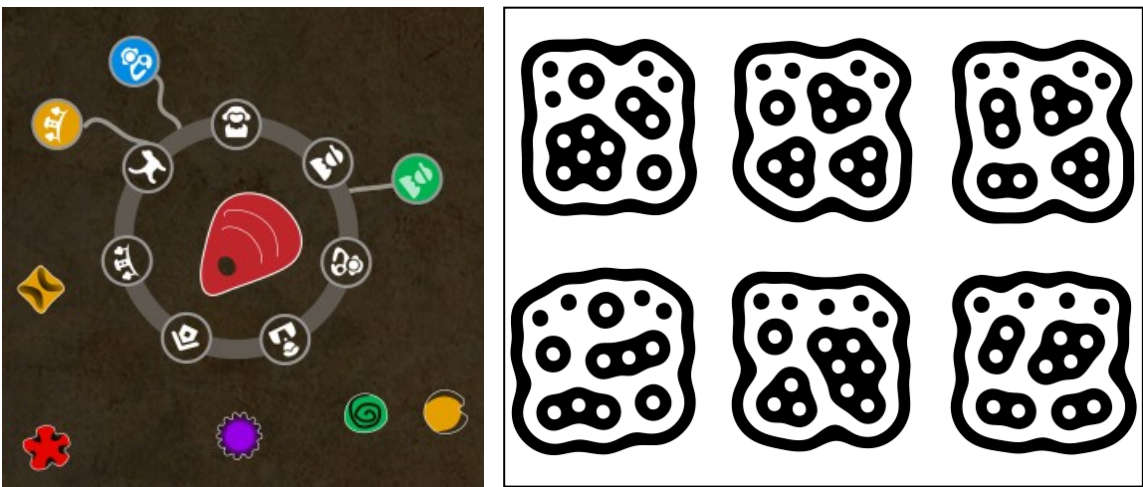


Figure 42: Left: Digital Lukasa developed at the Georgia Tech synlab, Right: reactIVision fiducial marker.

The process of combining and re-contextualizing cultural icons or symbols produces unique results independent of the intentions and vision of the original designer or artist. Thus, reappropriation, improvisation and conceptual remixing can be applied to visual art, video art and computing. These examples demonstrate Techno-Vernacular Creativity employed by visual, conceptual or vernacular mapping that tell or preserve cultural narratives and artifacts using developing technologies.

### **3.5. Techno-Vernacular Creativity in the Development of CSDTs**

TVC production techniques such as repetition and remixing have been integrated with the ethos of hip-hop culture that extends to computing. In looking at the relationship between coding and culture, Sherry Turkle (1995:52) discusses the “bricoleur style” of programming that contrasts the analytic methodology of Western science (see Lévi-Strauss, 1962) with an “associative science of the concrete” practiced in non-Western cultures. The bricoleur programmer works without preliminary specification, opting instead for a step-by-step growth and re-evaluation process. Turkle writes:

“Bricoleurs approach problem solving by entering into a relationship with their work materials that has more the flavor of a conversation than a monologue [Turkle, 1995:51].”

Turkle (1995) connects bricolage to the advent of personal computers that allowed for the manipulation of digital objects as opposed to code, thus lowering the technical bar to participation. Scratch, a multimedia-authoring tool developed at the MIT Media Lab, was derived from the DJ turntablist technique of scratching, relating the ease of mixing sounds to the ease of mixing projects [Schorow, 2007]. The University of California at Berkeley, in collaboration with Jens Mönig at MioSoft, developed a visual, drag-and-drop programming language that is an extended reimplementation of Scratch. SNAP! runs in a Web browser and, like Scratch, allows users to build their own blocks (scripts) to create new projects. The Culturally Situated Design Tool (CSDT) community of developers at Rensselaer Polytechnic Institute (RPI) used SNAP! to develop a platform that combines cultural designs and STEM. For this research project, I worked with CSDT developers Ron Eglash and Libby Rodriguez, and artists such as Sanford Biggers, Saya

Woolfolk and Xenobia Bailey to create CSDTs based on the artists' designs that show the formal possibilities of algorithmic modeling and geometric variation. [Figs. 43-45]

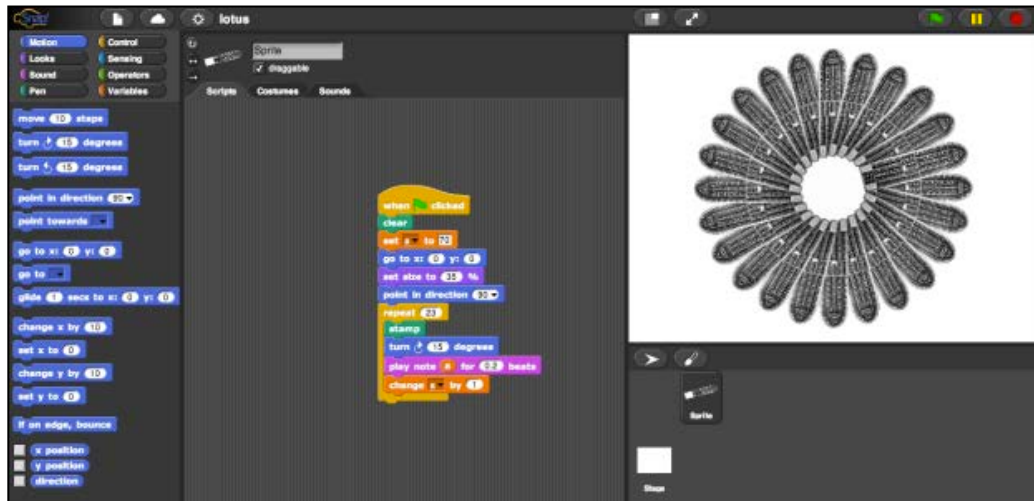


Figure 43: Lotus CSDT developed with Ron Eglash/RPI. Artwork by Sanford Biggers.

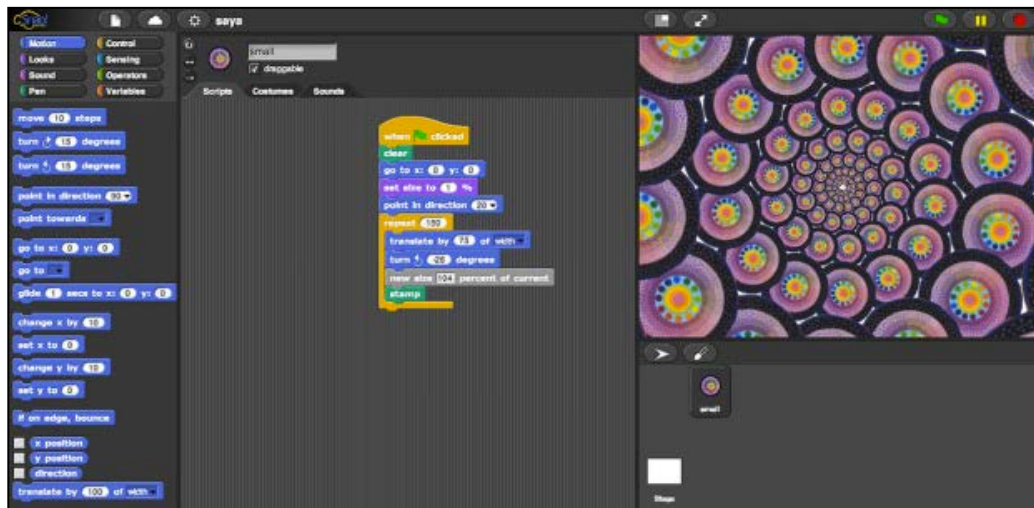


Figure 44: ChimaTEK CSDT developed with Ron Eglash/RPI. Artwork by Saya Woolfolk.

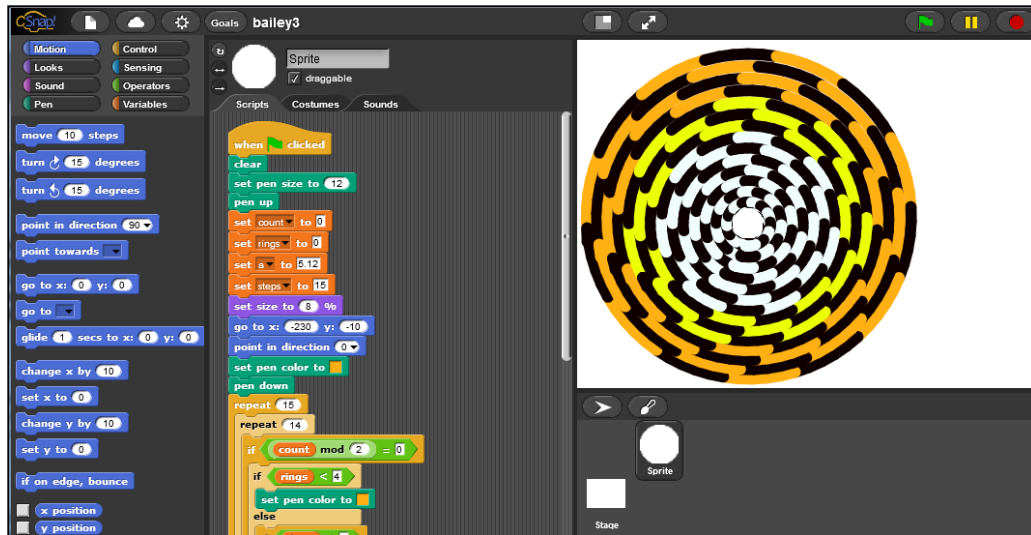


Figure 45: Mandala CSDT developed with Ron Eglash/RPI. Artwork by Xenobia Bailey.

Afrofuturism was coined by Mark Dery (1993) as “speculative fiction that treats African-American themes and addresses African-American concerns in the context of 20th century technoculture — and more generally, African-American signification that appropriates images of technology and a prosthetically enhanced future.” Pioneers such as jazz composer Sun Ra, Parliament/Funkadelic leader George Clinton, DJ Afrika Bambaataa, and dub music founder Lee “Scratch” Perry contributed to the early development of Afrofuturism. Visual artists such as Sanford Biggers, Saya Woolfalk and Xenobia Bailey combine these influences with TVC practices such as remixing and “mythmaking,” or combining different concepts, objects or identities [McCabe, 2011:56]. Sanford Biggers (Castro, 2012) defines afrofuturism as

“A way of re-contextualizing and assessing history and imagining the future of the African Diaspora via science, science fiction, technology, sound, architecture, the visual and culinary arts and other more nimble and interpretive modes of research and understanding.”



Conceptual remixing and bricolage underpins the mythmaking model in afrofuturism and other forms of African/African American cultural expression and storytelling. [Figs. 46-47] Bricolage computing remixes artifacts—whether music samples or symbols on a screen—as objects that are amenable to sampling, remixing and algorithmic modeling. Bricolage artifacts are “like physical objects—like dabs of paint or cardboard cutouts... Computational objects have always offered an almost-physical access to the world of formal systems [Turkle, 1995:52]”. Turkle (1995) notes that there have always been bricoleurs, or people whose way of interacting with computational objects had “more in common with the style of the artist than with that of the logician.”



Figure 46: Saya Woolfalk, “No Place (installation),” 2013.



Figure 47: Saya Woolfalk, “No Place (performance),” 2013.

Each tool developed for the AfroFuturism CSDT suite simulates a specific type of mandala—a generic term for any diagram, map or geometric pattern that represents the cosmos metaphysically or symbolically. The mandala is a container for information with different a meaning for each person, or culture it represents. The CSDTs afford users with design agency (see p. 47) to simulate mandalas and create designs in the same way artists do through sampling and remixing. Arts educators (see Guzzetti & Smalley, 2014) created curricula to explore how mandalas merge mathematics, culture, and art by creating patterns. My contribution to the CSDT project included the creation of curricula to support the development of the CSDTs. The following sections present case studies to illustrate how CSDTs and other applications engage TVC modes and characteristics.

### **3.6. Techno-Vernacular Creativity Case Studies and Projects**

#### **3.6.1. Introduction**

Artists capture the spirit of the techno-vernacular that drives much of African, African and Latino American, and Indigenous creative production. What often results is the invention of new practices, structures or symbols, and/or new ways to perform. African American culture from the Middle Passage to the present has been categorized by fragmentation, reassemblage, or recombination, sustaining what could be saved from the past through the making of something new (Alexander, 2003). Collage or the combining, layering, or translating of different materials



“Constructs wholes from fragments in a continual referential dialogue between the seemingly disparate shards of various pasts and the current work itself, as well as the future the work might point toward [Alexander, 2003].”

The first two sections (5.2 and 5.3) describe two projects I was directly involved in during the study. Another notable project is described in the last section (5.4) because it was developed using remixing and collage and study participants used the application during a preliminary STEAM learning workshop I conducted.

### **3.6.2. ISEA2012 STEMArts Visiting Artist Residency**

As part of the ISEA2012 STEMArts Education Program visiting artists were invited to lead summer workshops with youth. With the assistance of Georgia Tech graduate student Laurie Marion and the Wells Park Community of Albuquerque, New Mexico we engaged eight Latino American and Indigenous high school students in an interactive, physical mural design process that used vernacular art and technology to encourage the exploration of ISEA2012 themes. The goal was to employ a culturally situated arts-based learning strategy to give participants a rationale for engaging in STEM through mathematics, art and mobile augmented reality (AR). This project led to the development of curricula and a research model for facilitating STEAM learning among UEGs [Gaskins, 2013]. To summarize the process, we employed the following methods:

- Cultural heritage (e.g. ancient Mimbres) artifacts and vernacular art forms (e.g. street art) were provided as culturally relevant scaffolding [Gay, 2010] to address participants’ backgrounds and interests.

- Culturally Situated Design Tools (CSDTs) such as Graffiti Grapher to engage math and technology concepts tied to Next Generation Science Standards and simulate the participants' own designs. [Fig. 48]
- Participatory Design to tap participant knowledge, skills and understanding; to research themes based on cultural artifacts and vernacular art forms.
- A mobile AR platform that combines physical art with overlaid augmented reality (AR) content to be viewed with mobile devices such as iPads. [Fig. 49]

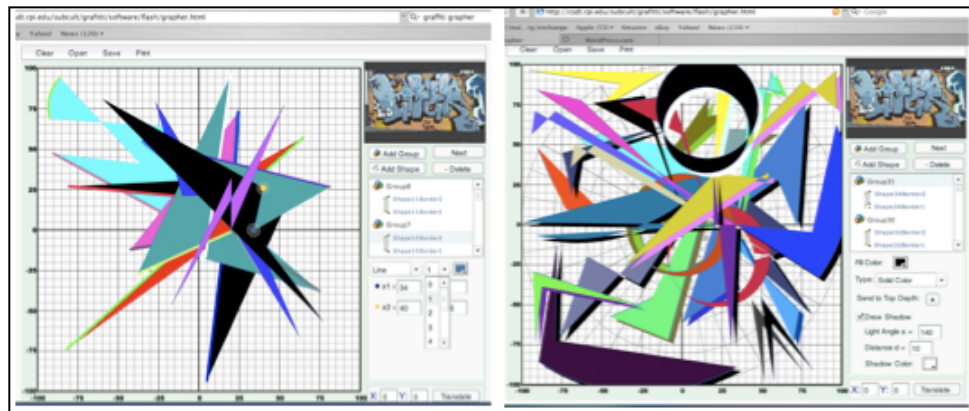


Figure 48: Graffiti Grapher CSDT in use for ISEA/AROS mural project.

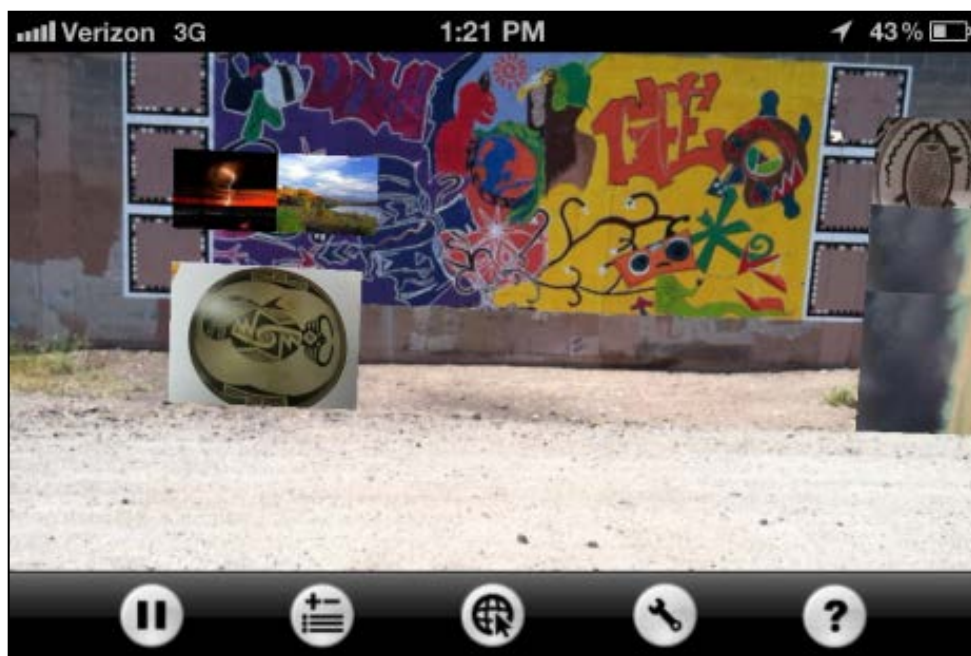


Figure 49: ISEA/AROS mural with cultural and mobile Augmented Reality artifacts.  
Cell phone image courtesy of Laurie Marion.

One of the challenges addressed in the STEMArts workshop was how to graphically translate mathematical systems. For example, Cartesian and polar coordinates that communicate cultural ethos (culturally relevant symbols, artifacts) are used in the design for a physical mural and with interactive, mobile AR elements. Participants researched the history and meaning of the ancient Mimbres pottery tradition in the American southwest. This included painted ceremonial bowls that are adorned with geometric and pictorial designs of animals, insects, mythical figures, and people. They viewed work by contemporary ethnic artists such as RETNA who combines influences from ancient cultural designs, calligraphy, and graffiti and Sanford Biggers who engages hip-hop subculture and cultural heritage artifacts from Asia, Africa, and North America.

Participants created their own designs on paper and used the Graffiti Grapher CSDT to simulate these designs. Participants combined their individual designs and ideas to create a composition for an outdoor, physical mural. One group painted the mural near the Wells Park Community Center. Another group worked on mobile augmented reality (AR) content for the community mural at the ¡Explora! science center. Participants created a collage of digital images of the New Mexico landscape, repeating the spatial pattern established in the mural. At Wells Park, participants used the grid method to scale up and paint the outdoor mural design. Mural grids used by artists are much like the Cartesian coordinate system in mathematics [Eglash et al, 2006, 2011]. This helped participants make the connection between art (graffiti) and math. As a final step, AR markers were painted on the sides of the mural. Digital image overlays and sound for the mural are triggered when pointing inboard cameras on mobile devices at the markers.

Based on informal participant observations and workshop materials collected during ISEA2012 we discovered that using content from diverse cultural backgrounds and providing access to digital media (laptops, iPads) inspires and engages youth from UEGs. In peer interviews, participants explained what they learned during the research and planning phase of the workshop.

*When I started, I looked at designs that would repeat and display a pattern. Then I looked up a few Mimbres art(work)s and I realized that they use a lot of animals in their art, so I took this design and applied it to different animals.*

*I'm drawing a bat right here and I got the idea from a Mimbres picture. So I'm doing my own spin off of it. I read that the bat means protection so I wanted to do that. At first I wanted to draw this Mimbres sea monster but I went with the bat because I wanted it to be symmetrical.*

The workshop demonstrated how culturally responsive instruction and technology could nurture underrepresented ethnic learners' cultural competence by using STEAM concepts and technology such as CSDTs and mobile AR. Most of the participants had no formal art training and had not used computers to create designs before the workshop. After the workshop, the participants talked to ISEA2012 conference attendees about their impressions of the project. Two participants stated that the workshop gave them technical skills (e.g. programming) they could use to find jobs. Some of the tools, materials and methods used in this project were later used to develop workshops at local research sites with specific focus on STEAM learning (described in Chapter 4).

### 3.6.3. Afrofuturism and CSDTs

AfroFuturism CSDTs explore algorithmic modeling and artworks that engage computational thinking principles. Certain artworks are amenable or open to algorithmic modeling than others—and ‘amenable’ here means more than just easy—a shape is easier to simulate and repeat but the process of repeating shapes to create designs is more about complexity arising from simplicity. One example mentioned in the previous section is Saya Woolfalk’s *ChimaTEK*, a series of multimedia installations that include mandalas. [Fig. 46] Museum curator Lowery Stokes Sims (2011) writes,

“[The artist’s] use of simple geometric shapes and primary colors ... encourage a transnational, un-xenophobic perspective that would lead us to open-minded future. Therefore we underestimate Saya Woolfalk at our peril, because it is conviction such as hers that can move cultures and shift the meta-narrative.”

For this project, I tested ChimaTEK and other CSDTs by creating sprites from the artists’ works, then animating them to create algorithmic designs. [Fig. 50-51] These designs simulated symmetrical design patterns created by the artists such as mandalas. These patterns reflect themes in afrofuturism as well as other creative and cultural expressions from around the world.



Figure 50: Saya Woolfalk, Left: “Empathics (installation),” 2012, Right: “Empathics (sampled for use in CSDT).”

For this study, I created a series of designs using the ChimaTEK CSDT to demonstrate for participating teachers, students and artists how these tools worked. [Fig. 50] Based on this preliminary work and with the artist’s permission, I designed a *Teacher Resource Packet* that contains instructional materials for the ChimaTEK CSDT. [Fig. 52] CSABL and STEAM learning workshop participants used ChimaTEK and the other AfroFuturism CSDTs to simulate artists’ works and create their own designs.

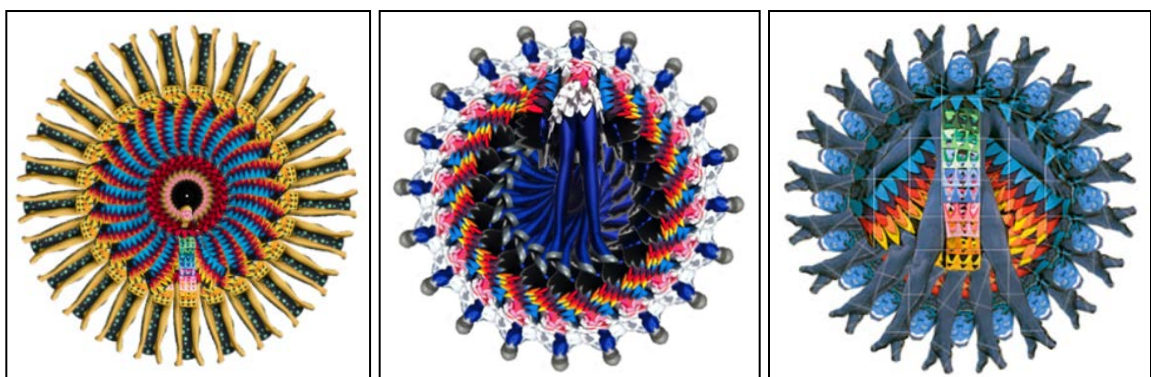


Figure 51: ChimaTEK CSDT designs by Nettrice Gaskins.



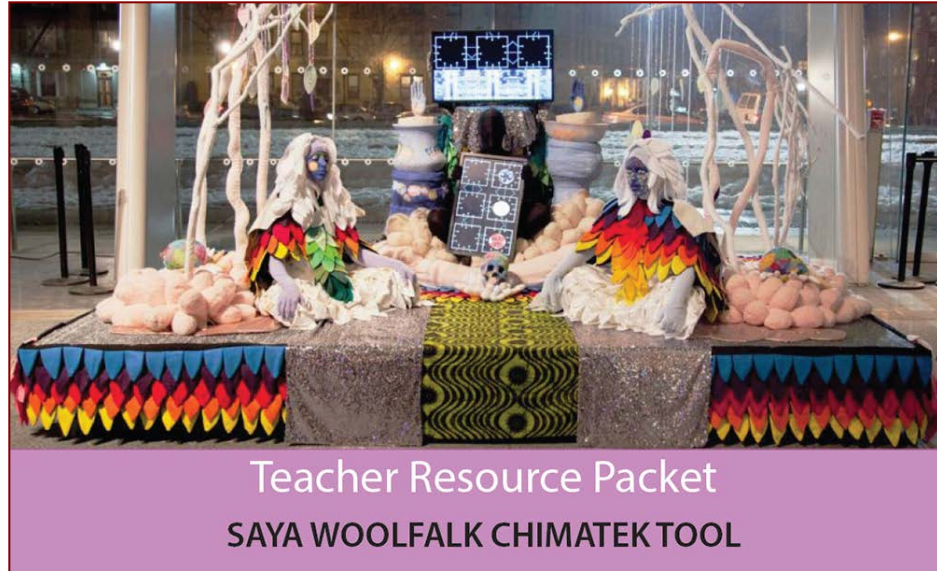


Figure 52: ChimaTEK CSDT Teacher Resource Packet by Nettrice Gaskins.

Similar research and preliminary work was completed for the Lotus CSDT with Sanford Biggers and the Mandala CSDT that uses Xenobia Bailey’s mandala designs that consist of crocheted, colorful concentric circles, shapes and repeating patterns that draw influences from African, Native American and Eastern philosophies. Bailey’s choice of crochet reflects the funk music aesthetic, and the dignity of labor in African American handcrafted traditions. Funk originated in the mid to late 1960s when African-American musicians created a rhythmic, danceable new form of music through a mixture of soul music, jazz, and rhythm and blues. [Fig. 53]



Figure 53: Xenobia Bailey Left: In her studio, Right: “One Nation Under a Groove (mandalas),” 2010.

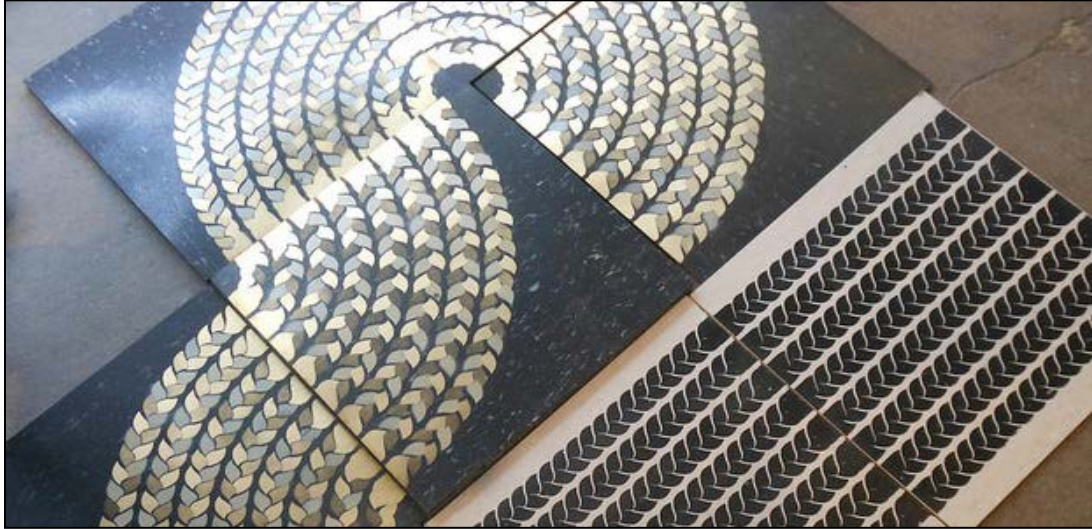


Figure 54: Nontsikelelo Mutiti, “Ruka art installation (floor tiles),” 2014.

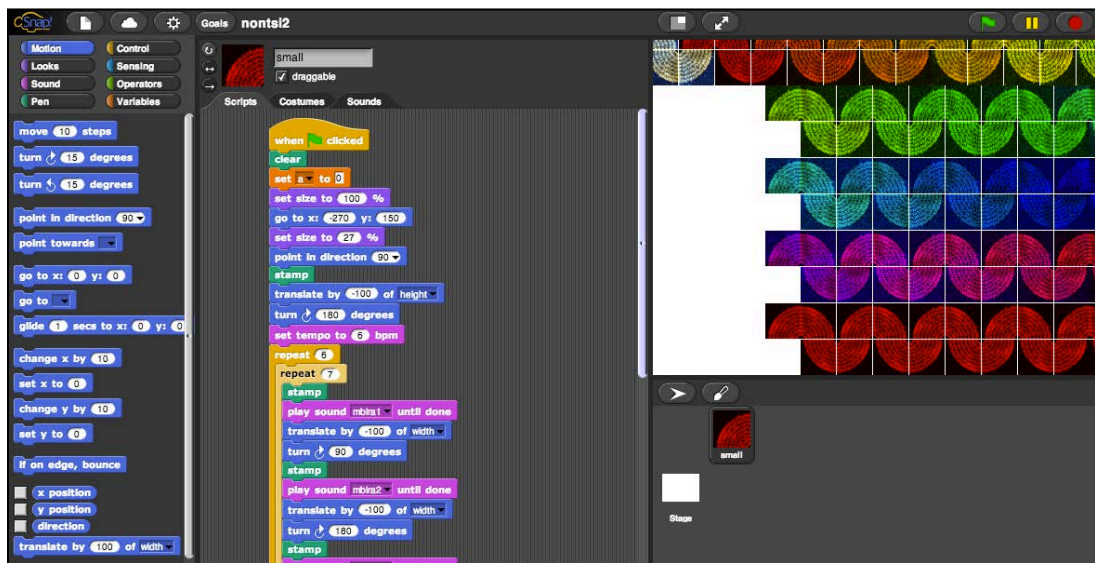


Figure 55: Ruka CSDT developed by Ron Eglash/RPI. Design by Nettrice Gaskins.

During a summer 2014 collaboration with Zimbabwean artist Nontsikelelo Mutiti for *Ruka* (*To braid/ to knit/ to weave*) at the New York-based Recess art gallery, I worked with Ron Eglash (RPI) to simulate floor tile designs screen printed by Mutiti that use algorithmic patterns: each tile consists of a group of cornrows, designed in such a way that different shapes are formed depending on how the tiles are arranged. The resulting patterns excavate the language and motifs associated with hair braiding across traditional



and contemporary contexts. [Fig. 54] For this project, Eglash created a CSDT that included sprites that play mbira music so users could ‘hear’ the angles that made the visual patterns. [Fig. 55] The mbira is an instrument that plays an important role in southeast African music. According to Nontsikelelo (personal communication), the mbira is one of the key traditional instruments used for divination in her father’s tribe. Mutiti’s artwork often incorporates shapes, colors and textures that can be layered, recombined or remixed. She extrapolates symbols from her African culture and family heritage, and then through repetition and rhythm she creates new designs. This process is similar to the computational thinking concepts explored in CSDTs.

#### **3.6.4. Romare Bearden Black Odyssey Remixes**

The traveling Smithsonian exhibition, *Romare Bearden: A Black Odyssey* presents the artist’s 1977 series of 20 collages based on episodes from Homer’s epic tale *The Odyssey*. Bearden reclaimed Western classical figures and replaced them with ideologies and perspectives of art that center on Black culture and life, or what has been referred to as the Black Aesthetic [Neal, 2000]. Bearden’s *Black Odyssey* represents the Middle Passage and reassembles displaced African and migrating African American bodies and cultural artifacts in unfamiliar settings. Bearden’s technique required that, for each piece of paper he cut out, the materials be allowed to respond to what was already laid down as if the pieces were notes in a musical composition. For example, *Sea Nymph* (see Fig. 56) shows Ino the sea goddess rescuing Odysseus from drowning by giving him a magic veil that would keep him afloat in the raging sea. In Bearden’s version Ino and Odysseus are black and the body of the hero is wrapped in a veil embedded with African Kente patterns that symbolize salvation.



Figure 56: Left: “Leucothea (Ino) & Palaemon,” Roman mosaic C4th A.D., Villa Romana del Casale, Piazza Amerina, Right: Romare Bearden, “Sea Nymph,” 1977.

Bearden, like many of his contemporaries, felt that, like jazz, collage uses improvisation as a key ingredient in the creative process. Improvisation is the “on the spot” or “off the cuff” spontaneous moment of sudden inventiveness that can just come to mind, body and spirit as an inspiration. Improvisation has been linked to traditional African American quilting – a technique also used by Bearden – which is the sewing of two or more layers of material together (see Wahlman, 2001) as well as remixing and sampling which are techniques used in music and video. Sampling does not merely repeat portions of material. Sampling reappropriates, improvises with, or rearranges materials to create new art forms. De Certeau writes,

“[active] users make (bricolent) innumerable and infinitesimal transformations of and within the dominant cultural economy in order to adopt it to their own interests and their own rules [de Certeau, 1984: xiv].”

Collage – the act of layering and putting disparate things together – represents many ideas of self (identity) and community that are complex. This includes mixing or

merging of multiple cultural narratives, materials and symbols as DJ Spooky – who is known for remixing D.W. Griffiths 1915 film, *Birth of a Nation* – describes of Bearden’s collages in the series *A Black Odyssey*,

“In the Black Odyssey he’s drawing a connection to the Greeks, the root of western civilization. So he’s looking at the roots of the west and the roots of himself and that’s a mash-up. He’s mashing up two records, he’s putting the Rolling Stones with Wu Tang Clan [SITES, 2012].”

In conjunction with the *Black Odyssey* exhibition, Smithsonian Institution Traveling Exhibition Service (SITES) developed a mobile application or ‘app’ to connect people to the creative and innovative practices of Bearden. This app presents information from *A Black Odyssey* and allows users to simulate collage, sampling and remixing on mobile devices such as iPads. [Fig. 57] African American artists—whose works are integral to this dissertation— DJ Spooky, Sanford Biggers and Hank Willis Thomas helped launch the *Remixes* mobile app at the DC Moore Gallery in New York City.



Figure 57: From left: Igbo artist (Nigeria). “Shrine sculpture for Mami Wata,” 1950s. Courtesy High Museum of Art; Romare Bearden. “Circe,” 1977. Courtesy Estate of Nanette Bearden and DC Moore Gallery, New York; Nettrice Gaskins. “Circe (Mami Wata),” with Black Odyssey Remixes app.

Collage—layering or masking diverse materials—suggests the cultural hybrid nature of the ethnic, non-white artist – one who sees himself as an individual and one who is seen by a mainly white audience. This struggle reflects W.E.B. Du Bois’ (1903) concept of the “double consciousness,” or “this sense of always looking at one’s self through the eyes of others.” However, contemporary African American artists and scholars are revising Du Bois’ “two-ness” trope. Elizabeth Alexander (2003) contends that if the African American intellectual consciousness is split, it is split multiply rather than doubly, and that that so-called fragmentation, arisen from the fundamental fragmentation of the Middle Passage, has become a source of African Americans’ creative power. The complex co-existence of a spectrum of black identities in a single represents a particular strength and coherence of African American cultural production.

## CHAPTER 4: METHODOLOGY

### 4.1. Overview

Chapter 1 introduced the subject of this dissertation and that is investigating how Techno-Vernacular Creativity (TVC) in underrepresented ethnic communities of practice (ECoPs) and how these modes can increase interest and motivation in STEAM among underrepresented ethnic groups (UEGs) in informal learning settings. The focus is on the significant TVC characteristics that influence the engagement of UEGs in STEAM and how to incorporate these characteristics in informal science education. Chapter 2 looked at the theoretical frameworks, prior works and strategies that combine culturally situated art-based learning (CSABL) with learning science. Chapter 3 looked at TVC in research and practice, including relevant projects and case studies. The investigation of TVC through CSABL in STEAM addressed the key research question:

**Does Techno-Vernacular Creativity within an informal learning environment (ILE) increase interest and personal motivation in ethnic groups who are underrepresented in STEAM?**

This chapter explains the research methods used to generate the data in this study. This study employed Constructivist Grounded Theory (CGT) and Participatory Action Research (PAR), through vernacular art, crafts, and technology for the delivery and presentation of creative tactics, strategies, and instructional workshop content. This study employed the research methods in two types of interventions: a professional workshop for culturally situated art-based learning and a workshop for middle school students that nurtured STEAM learning by, as Barron (via Eberbach & Bernstein, 2009) describes it,

“seeding” the learning environment with supportive, culturally responsive resources. Details about these workshops are in the following sections.

## **4.2. Strategies of Inquiry**

### **4.2.1. Introduction**

“The researcher, in turn, may be seen as a bricoleur, as a maker of quilts, or, as in filmmaking, a person who assembles images into montages. [Denzin & Lincoln, 2008]”

Maps or mapping and quilting are concepts I used to connect various project activities, from studying historical and repurposed quilts and Lukasa memory boards to creating murals with mobile augmented reality markers. Professional workshop participants created concept maps. School-based workshop participants made vision map designs and collages, and they visited a museum to learn about vernacular maps such as Lukasa (p. 74) and the technology created to simulate related mapping concepts. I used the Denzin & Lincoln (2008) quilting concept to describe the process of collecting, analyzing, extracting, and piecing together meaningful information. In the sections that follow I describe the research methods, tools and strategies used to conduct this study.

Participatory Action Research (PAR) is defined as collaborative research, education, and action used to gather information to use for change on social issues [Kindon, Pain & Kesby, 2007]. It involves people who are interested in, concerned about, or affected by an issue taking a leading role in producing and using knowledge about it. The PAR model used in this study involved recurrent stages of planning, action and reflection, followed by evaluation.

The primary purpose of Constructivist Grounded Theory (CGT) is to get beyond the surface in seeking meaning in the data, searching for and questioning tacit meanings about the subjects' values, beliefs, and ideologies [Charmaz, 2006]. Rooted in pragmatism and relativist epistemology, CGT assumes that neither data nor theories are discovered, but are constructed by the researcher as a result of his or her interactions with the field and its participants [Charmaz 2006; 2009]. Data are co-constructed by researcher and participants, and colored by the researchers' and participants' perspectives, values, privileges, positions, interactions, and geographical locations. This position takes a middle ground between the realist and postmodernist positions by assuming an "obdurate reality" at the same time as it assumes multiple perspectives on these realities [Thornberg, 2012:243].

For this project, I used Constructivist Grounded Theory (CGT) and Participatory Action Research (PAR) as a foundation for different theoretical, conceptual and methodological approaches to mixed-methods research. [Fig. 58] By combining multiple methods, activities, theories and contexts, the goal was to develop a research model that resembles a quilt: built piece- by-piece by reclaiming theories, improvising with techniques, and remixing strategies to create a new design. Denzin & Lincoln (2008:5) note that the qualitative researcher or "bricoleur" uses a variety of aesthetic and material tools to deploy specific strategies, methods, and empirical materials. Their use of the terms bricoleur, quilting and improvisation to describe qualitative research design methods is relevant to this project, which used a constellation of interviews, projects, workshops, and questionnaires deploy a range of interconnected interpretive practices, to get a better understanding of the problem [Denzin & Lincoln, 2008:4].

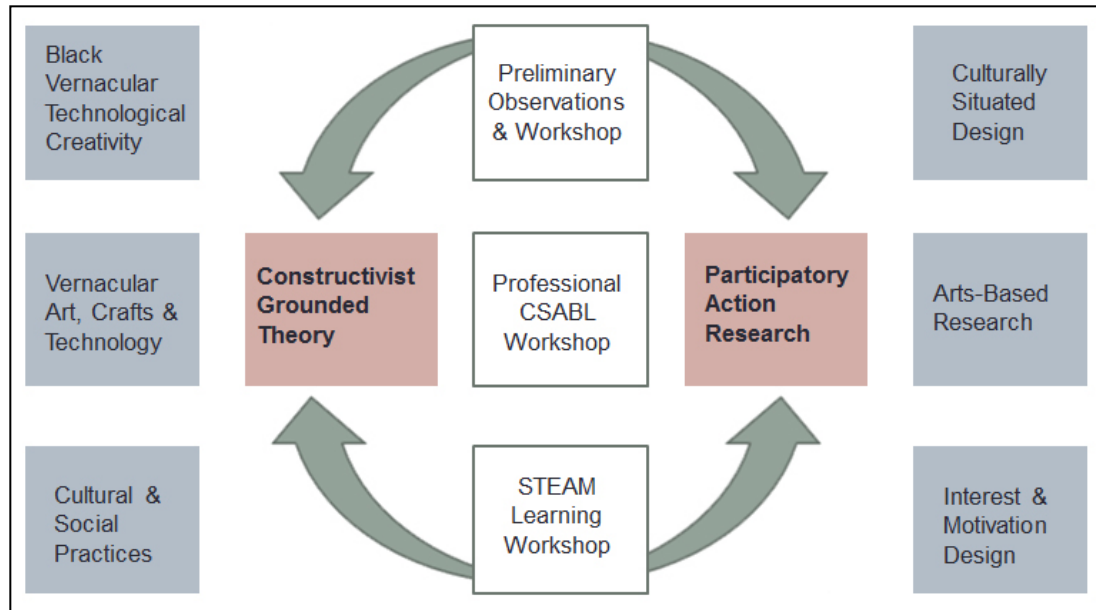


Figure 58: Research methods (pink), activities (white) and key theories & models (blue).

For this eight-month study, I conducted a series of workshops aimed to explore the project’s core research question. Details about the workshops are in the following sections. Below are descriptions for each of the workshops, in chronological order:

- Preliminary observations and workshops conducted at Drew Charter School with 4th and 8th grades in preparation for a more informal learning workshop
- A professional informal science learning workshop at Georgia Tech to investigate effective strategies to engage the target group in STEM
- An informal STEAM learning workshop conducted at Lithonia Middle School and Georgia Tech with 6<sup>th</sup> – 8<sup>th</sup> grades in an afterschool program

#### 4.3. Preliminary Observations and Workshops at Drew Charter School

The work described in this section combines different informal learning frameworks to understand how Techno-Vernacular Creativity (TVC) can lead to an increase in UEG interest and intrinsic motivation in STEAM. Constructivist Grounded



Theory (CGT) was a method that was used for data analysis and interpretation. Specifically, I conducted preliminary participant observations and workshops at Drew Charter School (DCS) to develop a TVC learning ecology to provide the target group with specific resources and opportunities for learning (see Barron, 2006:195).

#### 4.3.1. Location and Participants

Participant observations and workshops were held at DCS on October 14, 2013, March 7 and April 30, 2014 to explore key theories and models, and to test new tools being developed for the study. [Fig. 59] DCS administrators and teachers selected classes and students to participate in the study. Two hundred (200) 4<sup>th</sup> and 8<sup>th</sup> graders from DCS were recruited to participate in STEAM learning activities. DCS students were 89% African American, 2% Hispanic/Latino with less than 9% White/Other [NCES, 2012].

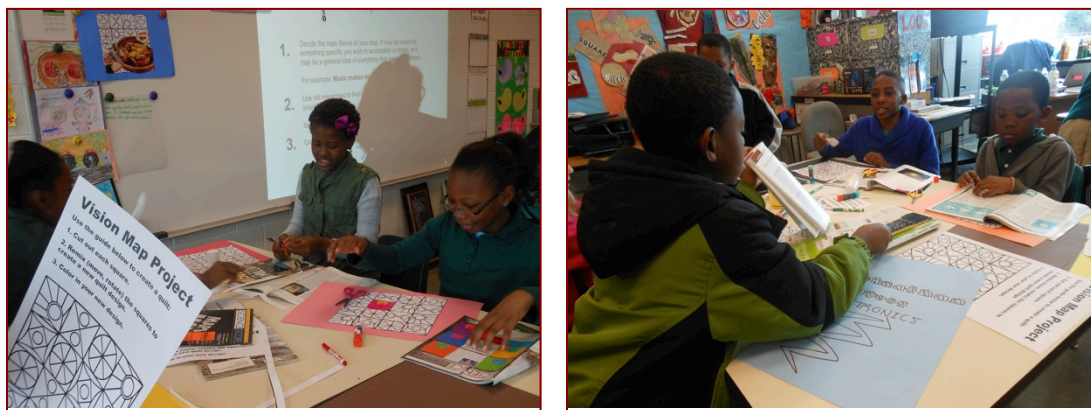


Figure 59: STEAM Discovery Day with 4<sup>th</sup> graders at Drew Charter School.

#### 4.3.2. Data Collection and Procedures

On-site research took place at DCS during school hours beginning with participant observations in 4th grade math classes and workshops with 8<sup>th</sup> grade math classes. For this project, I used Howell's (1972) Participant Observation Phases including: establishing rapport with key stakeholders, immersing oneself in the field,

recording data and observations, and consolidating the information gathered. Data were used to design a more informal STEAM learning workshop (see section 4.5).

The 8<sup>th</sup> grade workshop began with an introduction and group discussion of works by contemporary artists who explore mapping and use geometric diagrams or designs in their work. Ethiopian American artist Julie Mehretu's works refer to elements of mapping and architecture. Sanford Biggers—a colleague of Mehretu's—uses historical quilts and star charts. [Fig. 60] The artists' works and other visual stimuli were used to motivate participants to explore, learn and actualize their ideas [Coon & Mitterer, 2010].



Figure 60: Left: Julie Mehretu, "Liminal Squared," 2013, Right: Sanford Biggers, "Constellation (Stranger Fruit)," 2009.

#### 4.3.3. Instruments

For this project, I developed and adapted tools and metrics to capture participants' engagement with Techno-Vernacular Creativity and to foster the target groups' exploration of STEAM concepts. Specifically, I customized version of Personal Meaning Maps (PMMs). Originally, PMM was derived from Concept Mapping (see Novak & Gonzalez, 2004; Falk, 2003) and it involves open-ended interviews, before and after the educational experience. Using the PMM, participants are given prompts (key words or phrases) and invited to write or draw anything the word/phrase reminds them of. Once

completed, they are asked to make amendments to the responses or add more information. [Fig. 61] PMM analyzes responses along with four semi-independent dimensions: Extent, Breadth, Depth and Mastery. This analysis is useful to illustrate the learning outcomes from the same educational experiences across the different learners.

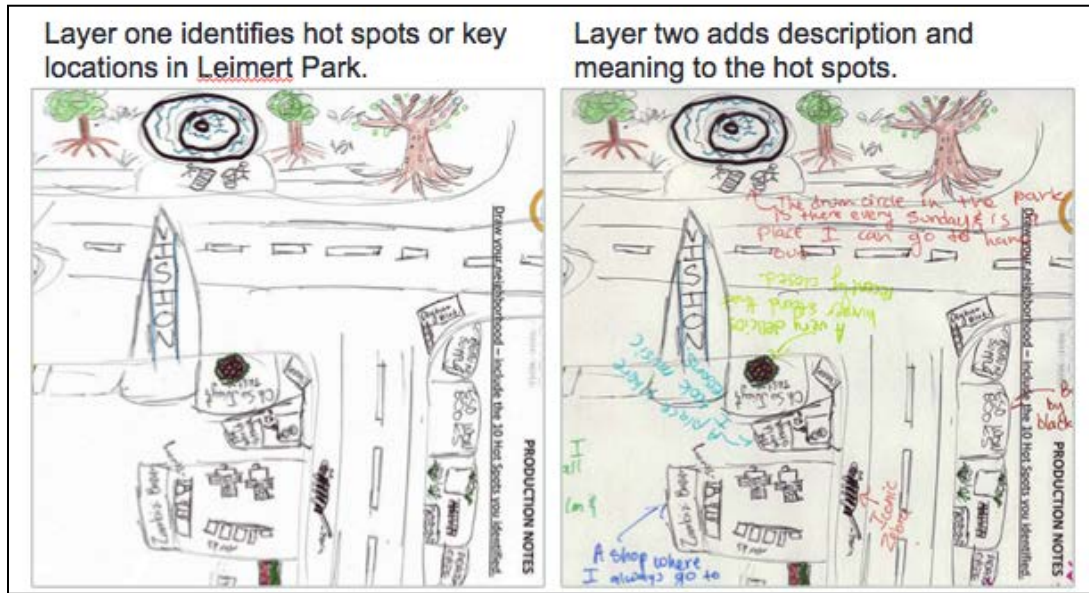


Figure 61: Anbiya Smith, “Personal Map of Leimert Park,” July 10, 2013.  
Courtesy KCET KAOS Network Youth Voices.



Figure 62: Left: Lucy Aldrich. “Gee’s Bend Quilt.” Right: Quilt Design Template.

The customized version of the PMM used in this study is a vision map. Vision mapping uses a paper-based design tool to simulate and study improvisational quilting and collage. [Fig. 62] Like PMMs, vision maps are used to explore personal themes and interests. Researchers view these themes/interests as “assets on which learning can occur” [Scott, Sheridan & Clark, 2014:3]. Vision mapping explores Techno-Vernacular Creativity (TVC) through layering and modularity or the degree to which a system’s components may be separated and recombined. The first layer is a pattern that consists of modules (symbols, shapes) that can be remixed to create designs or collages. A second layer can be added using semi-transparent paper for text and drawings.

The *Romare Bearden Black Odyssey Remixes* app was installed on iPads at DCS to allow participants to practice remixing collages, translating shapes, and combining images and sound. The results of this work are in Chapter 5 (Results and Findings).

#### **4.3.4. Arts-Based Inquiry and Group Discussion**

For the workshops at Drew Charter School (DCS), I created arts-based inquiry questions and motivational prompts to grab participants’ attention during group discussions. This framework included key learning strategies, Keller’s ARCS model (p. 54) and Falk & Dierking’s informal learning contexts (p. 57) to promote close-looking (p. 51) and deeper understanding of vernacular art, crafts and STEAM concepts. [Fig. 63] This inquiry-based approach was used in a subsequent STEAM learning workshop.

	Personal Context	Physical Context	Socio-Cultural Context
	Culturally Situated Design	Arts-Based Learning	Digital Media/ Technology
Engagement →	Write/talk about the artist's culture(s) in this work.	Write/talk about what you see in this art.	Write/talk about the type technology you used.
Relevance →	Write/talk about how this artist's culture relates to your culture.	Write/talk about what comes to your mind when you look at this art.	Write/talk about how this technology can be used to create things you like.
Confidence →	Write/talk about how you felt about learning this artist's culture.	Write/talk about how well you think you can make this art.	Write/talk about how you felt about using the software.
Satisfaction →	Write/talk about what you liked and did not like about the artist's culture.	Write/talk about how this art is similar to other art you like.	Write/talk about what you liked and did not like about the software.

Figure 63: Key learning models with arts-based inquiry & motivation prompts.

#### 4.3.5. Analysis of Vision Maps

For this project, I created and used a rubric to assess participants' understanding of vision maps; extent is designed to capture this dimension of learning [Falk, 2003; Falk & Storksdieck, 2005]. Breadth measures changes in the number of conceptual categories an individual uses to describe the prompt. Breadth, thus, measures a fundamental aspect of learning than an idea of phenomenon can be understood in more than one way. As with the breadth score for the open-ended question, coding categories emerged from the data and were refined in an iterative process. Depth measures the changes in degree of understanding within each breadth category and is therefore a measure of conceptual understanding. Mastery is a more holistic assessment that takes into account all of the things a participant did or said during the process, in order to gauge where the participant falls along a continuum between novice and expert relative to the specific concept. The results of this work are in Chapter 5 (Results and Findings).



### Rubric for Vision Map Assessment

Extent	Breadth	Depth	Mastery
Uses diagramming with a given number of samples.	Uses different ways to combine or mix patterns through collage, repetition, translation, etc.	Uses visual storytelling with diagramming to show deeper understanding of concepts.	Shows comprehensive knowledge or skill in diagramming.
Creates diagram using preexisting design.	Creates diagram by remixing or repeating samples.	Creates diagram with multiple patterns or groups of patterns.	Creates diagram using new media and different techniques.
Uses at least one math concept – i.e. rotation.	Uses more than one math concept such as rotation and translation.	Uses advanced math concepts such as fractals.	Uses advanced math with other STEM concepts.

Figure 64: Vision map rubric with informal learning capacities and math concepts.

The use of Techno-Vernacular Creativity and STEM concepts in participants' vision maps would be examined, organized and then coded based on extent, breadth, depth and mastery [Falk & Dierking, 1992; 2000; Genovesi, 2011]. The vision maps were scored on a scale from 1-5 (low to outstanding), using geometry concepts and the TVC learning ecology in Chapter 2 (section 2.6). These results would be used to triangulate findings from other data sources.

#### 4.4. Professional Culturally Situated Arts-Based Learning Workshop

For this study, I conducted *Advancing STEM Through Culturally Situated Arts-Based Learning*, a professional workshop sponsored by the National Science Foundation (NSF) to investigate the role that culture and art plays among underrepresented ethnic learners that, as studies show, are increasingly uninterested and disengaged in STEM. The primary goals of the workshop were to engage a dialog among experts in Learning Sciences, Culturally Situated Design, Education, as well as practitioners, to advance the understanding of the potential impacts of culturally situated arts-based learning to extend

participation and understanding of STEM. This project involved the collaboration of a team that included me as the Director, Celia Pearce (my thesis advisor) as Principal Investigator, with additional support from Ivan Allen College Dean Jacqueline Royster and Digital Media program staff. As per requirement by the NSF, an external evaluator was required to capture the impact and outcomes of the workshop. Tom McKlin of SageFox Consulting filled this role as part of the grant budget.

This chart (see Fig. 65) that was adapted from Kindon, et al. (2007) describes the stages of the CSABL workshop:

Phase	Action
Action	Establish relationships and common agenda with stakeholders
Reflection	On research design and knowledge.
Action	Build relationships Identify roles and responsibilities Collectively design research processes and instruments Discuss potential outcomes
Reflection	On research questions and design
Action	Work together to implement research and collect data Enable participation of all members
Reflection	Begin to work on feeding research back to participants and plan for feedback on process and findings
Action	Collectively identify future research and impacts

Figure 65: Participatory Action Research phases and actions.

#### 4.4.1. Location and Participants

A professional two-day culturally situated arts-based learning (CSABL) workshop was held at Georgia Tech on March 28-29, 2014 with experts in Learning Sciences, Culturally Situated Design, Arts and Crafts and Education. This included twenty-one (21) people from diverse backgrounds, disciplines/fields, age groups and affiliations. Eleven (11) participants were African American (not including me as the project's director), two

(2) were Native American/Indigenous, and eight (8) were White/Caucasian. The purpose of this professional workshop was three-fold, namely

- To engage a dialogue among researchers, artists mostly from underrepresented ethnic communities of practice, whose work integrates informal science education through its content, methodology, and technological implementation,
- To advance the understanding of the potential impacts of culturally situated design strategies and present arts-based learning and research methods that can extend participation and understanding of STEM, and
- To build capacity for sustained collaboration across disciplines for the benefit of research and practice

The workshop included artist keynote presentations with Sanford Biggers and Vanessa Ramos-Velasquez. Synergistic activities included a Creative Social/performance (for workshop participants and others) with Sanford Biggers and his band Moon Medicin that took place at Georgia Tech's Ferst Center for the Arts. Biggers' visit was sponsored by Georgia Tech's Office of the Arts, in conjunction with Africa Atlanta 2014, an event organized by the Ivan Allen College of Liberal Arts in collaboration with the Consulate General of Belgium in Atlanta, and other partners.

#### **4.4.2. Data Collection and Procedures**

For this workshop, I used the Participatory Action Research (PAR) method to lead a team that worked on a research design and evaluation plan that was used in the workshop. The workshop plan defined relationships among the participants and matched them according to overlapping areas of interest. Based on this plan, I created materials that included a workshop website, schedule, and activities. Prior to the workshop, I



created and disseminated seed questions to help participants prepare and submit either a one-page projection/slide or 2-3 images/artworks as preparation for the workshop activities. During the workshop, I led sessions in which participants explored culturally situated design, arts-based research, and digital media and learning. Each session included a short presentation and breakout groups where participants explored key issues related to the given topics. For example,

- What art forms or artifacts from specific times, places and ethnic cultures use STEM concepts?
- How can practitioners (teachers, artists, etc.) make these artifacts and concepts more explicit in their work?
- How do culturally situated design tools and strategies engage students from underrepresented ethnic groups?

External evaluator Tom McKlin developed an online questionnaire before the workshop, Social Network Analysis (SNA) forms before and after the workshop, a feedback form after the workshop and follow-up interview questions. Details regarding the procedures for each of these techniques are described in McKlin's report (2014).

#### **4.4.3. Instruments**

The CSABL project team worked collaboratively on the overall research design that was used by the evaluator to create instruments for the workshop. The evaluation plan was designed to provide objective feedback of both performance and results measures. The design of the evaluation emanated from a logic model (see Fig. 4) to provide ongoing, formative feedback as well as a summative evaluation. Participants completed four separate survey instruments allowing for analysis on workshop benefits:

1. Questionnaire administered weeks before the workshop, via SurveyGizmo, including open - ended questions addressing participants' reasons for involvement and concerns.
2. Social Network Analysis form administered at the beginning of the workshop to identify connections that were already present in knowledge, influence, and collaboration.
3. Social Network Analysis for administered at the end of the workshop to identify influence and future collaboration efforts.
4. Workshop Feedback form administered at the conclusion of workshop to identify workshop benefits.

In addition to these instruments, concept maps were used to explore broad themes or concepts, connecting them through linking artifacts and artworks with other concepts or ideas. For the CSABL workshop, I developed a concept mapping device for representing STEAM concepts embedded in a culturally situated arts-based learning framework [Fig. 66] Details regarding the results of this work are in Chapter 5 (Results and Findings).

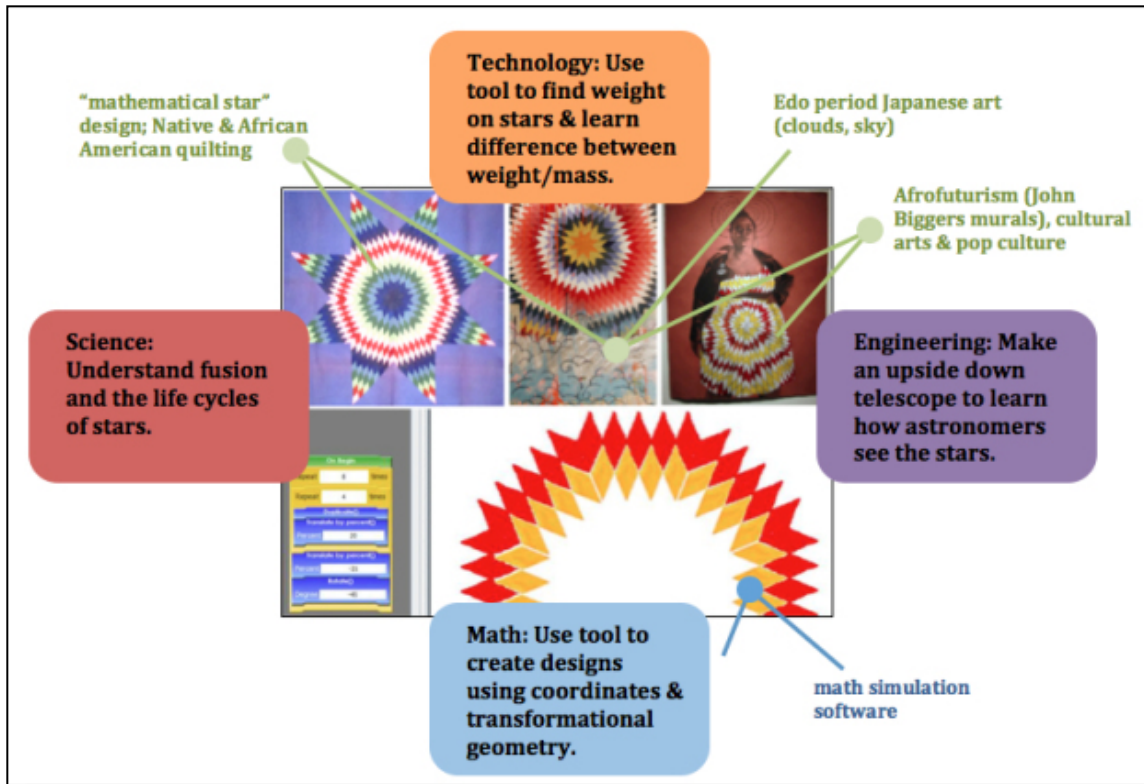


Figure 66: CSABL STEAM concept map by Nettrice Gaskins.

#### 4.4.4. Breakouts and Group Discussions

At the workshop, I conducted three short 15-minute presentations that were followed by three *Research Goals Brainstorms* breakout sessions in each topic area (culturally situated design, arts-based research and digital media). The presentations included preliminary findings from the participant observations and workshops at Drew Charter School. The breakout sessions were designed to promote integration of diverse disciplines and groups, and generate significant reconceptualization in the topics of the preceding presentations.

Group discussions were designed to explore general strategic approaches that can be applied to future research in the enhancement of culturally situated arts-based

learning. The external evaluator will conduct post-workshop interviews after the conclusion of this research project (July-August 2014).

#### **4.4.5. Data Analysis**

For this workshop, the project team conducted different types of data analyses. Members of the team worked with external evaluator Tom McKlin to design tools to assess whether or not the workshop met its goals. McKlin conducted pre and post-workshop questionnaires, post-workshop interviews and Social Networking Analysis to assess the group's capacity to build sustained collaboration across disciplines. The workshop feedback form is in the Appendix. I conducted a qualitative analysis (see 4.4.2.) to assess participants' use of concept maps, specifically, the connections that participants made across concepts or bodies of knowledge.

#### **4.5. Lithonia Middle School STEAM Learning Workshop**

Prior observations and workshops culminated in the full implementation of an informal STEAM learning workshop at Lithonia Middle School (LMS). The goal of this workshop was to investigate different informal learning contexts and models: Contextual Model of Learning (p. 61), Connected Learning Model (Ito, et al., 2008; 2009), and a culturally responsive teaching model (Scott, Sheridan & Clark, 2014) to develop a learning ecology that explored Techno-Vernacular Creativity (TVC) and STEAM. [Fig. 67] Another goal of the workshop was to study different pathways to interest development (see Barron, 2006). The final task was to measure the motivational characteristics of the target group using a retrospective pre-post self-assessment developed using Keller's (2010) Instructional Material Motivational Survey, or IMMS.

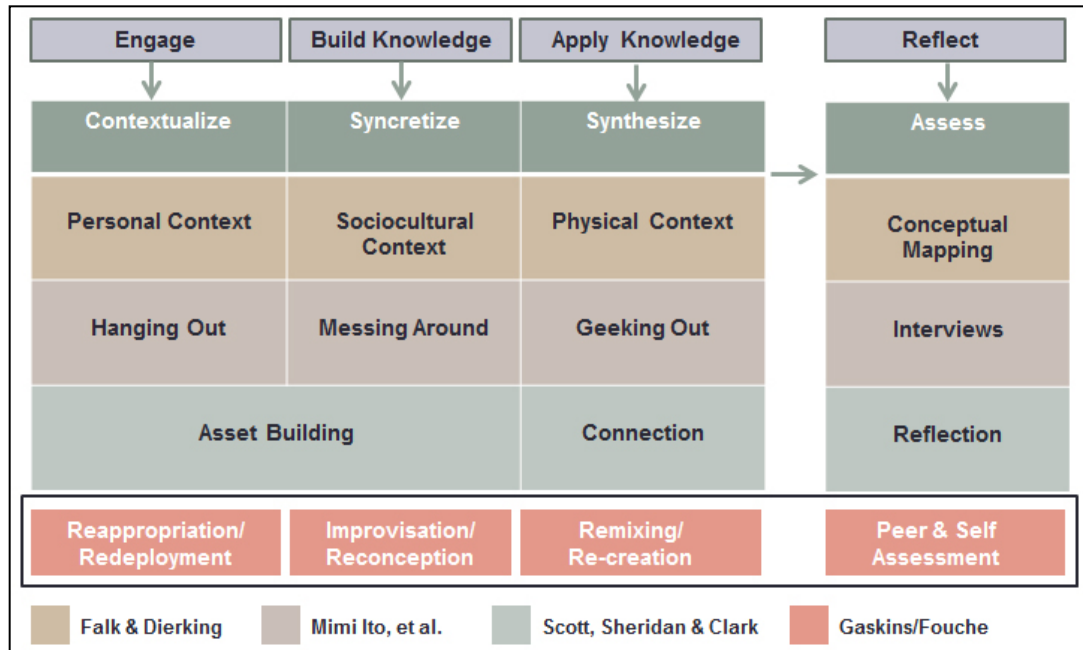


Figure 67: Informal learning contexts and models.

The STEAM learning workshop primarily used the contextual model of learning and a culturally responsive teaching/computing model to look at how underrepresented ethnic learners processed cultural information from vernacular art and crafts such as quilts and maps and technology. The purpose of this workshop was:

- To establish relationships and build rapport with key stakeholders,
- To gather rich data such as workshop materials, field notes from observations, photographs, videotaped semi-structured interviews, and questionnaires as a foundation for building a significant analysis,
- To pilot instructional materials and tools for project participants and collaborators (e.g. teacher packets for CSDTs and vision map templates),
- To investigate how UEGs contextualize, syncretize and synthesize cultural information in vernacular art and crafts, using TVC practices and technology, and
- To assess the level of interest and intrinsic motivation among participants.

TVC practices were explored through vision mapping that provided a rationale for teaching STEAM concepts. Workshop materials included instructional units (teacher resource packets), a group discussion presentation, interview questions, and a retrospective pre-post questionnaire.

#### **4.5.1. Location and Participants**

This workshop was held at Lithonia Middle School (LMS) during the week of May 5-9, 2014, including a field trip to Georgia Tech's Robert C. Williams Museum of Papermaking for *Mapping Place: Africa Beyond Paper*, an exhibition that explored traditional and vernacular cartography such as Lukasa boards and other mapping technologies. Thirty-five (35) LMS 6<sup>th</sup> and 7<sup>th</sup> graders from LMS) were recruited to participate in a STEAM workshop. LMS students were 95% African American, 4% Hispanic/Latino, and 1% White/Other [NCES, 2012]. On-site workshop activities took place after school with students from art and technology clubs.

#### **4.5.2. Data Collection and Procedures**

For this workshop, I used Constructivist Grounded Theory (CGT) to combine different informal learning contexts and strategies to look at how TVC increases interest and motivation in STEAM among the target group (see Fig. 58). This combined model corresponds with learning sciences research about young peoples' exploration of art and digital media, i.e. in interest-driven activities where they can create and navigate new forms of expression [Ito, et al., 2008]. The workshop plan included:

- Relating participants' personal interests and new knowledge such as the artwork of Sanford Biggers who was granted a special residency as part of Africa Atlanta

2014 at Georgia Tech. Biggers was selected because of his background as a former graffiti artist and break dancer, and his use of cultural artifacts and STEM.

- Helping participants acquire various forms of technical and media literacy by exploring new interests, tinkering, and “messing around” with new forms of media. This required giving participants access to culturally situated design tools (CSDTs) to remix Biggers and other artists’ works and a digital Lukasa table.
- Creating personal connections and interactions at the middle school and the Museum of Papermaking at Georgia Tech.

Specifically, I used a variety of learning tools and strategies such as vision mapping, group discussion, arts-based inquiry and motivation prompts, and self-assessment. Preparations included:

- A quilt design template for a *Vision Mapping* exercise,
- Culturally responsive visual artifacts and cultural scaffolding activities to engage UEGs, using TVC practices, and
- Concepts and pedagogy to RPI for the development of AfroFuturism CSDTs to be used during the workshop.

Different artworks were selected that show the dynamic between cultural information and creative or personal expression. [Fig. 68-70] These works included vernacular maps that represent cultural symbols, rituals and values of the communities that create or use them. Lukasa memory boards are encoded with symbolic signs that represent stories [Vansina, 1996:12]. Star quilts, traditional African American quilts and the contemporary artworks that repurpose these quilts and quilt-based designs have



retained an indigenous and African aesthetic preference for improvisation and creative practices similar to those found in jazz and hip-hop [Wahlman, 1999:45]. Images included the African cultural practice of cornrow braiding that is based on iterative geometric transformations of scaling, rotation, reflection, and translation [Eglash, 1999].

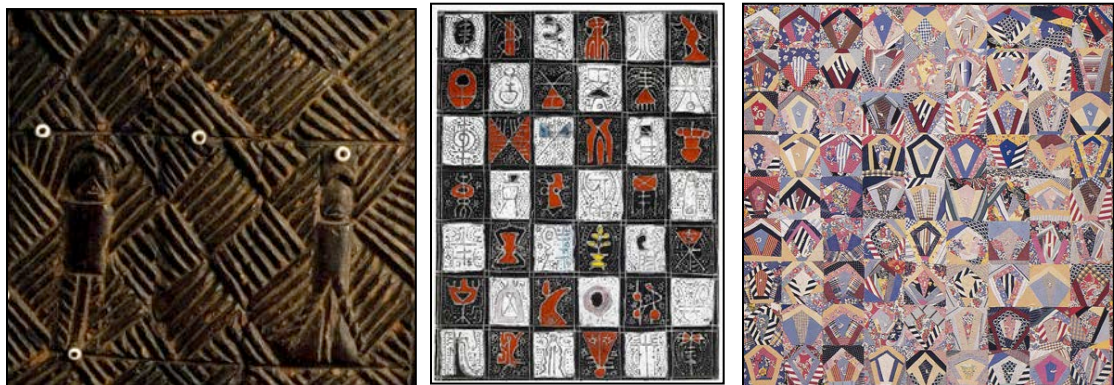


Figure 68: Left: Lukasa (detail), late 19th century. Courtesy University of Iowa Museum of Art, Middle: Bruce Onobrakpeya, "Ibiebe ABC III," 2000, courtesy the National Museum of African Art, Right: 1940s improvisational quilt (detail) by an unknown maker, courtesy of Eli Leon.

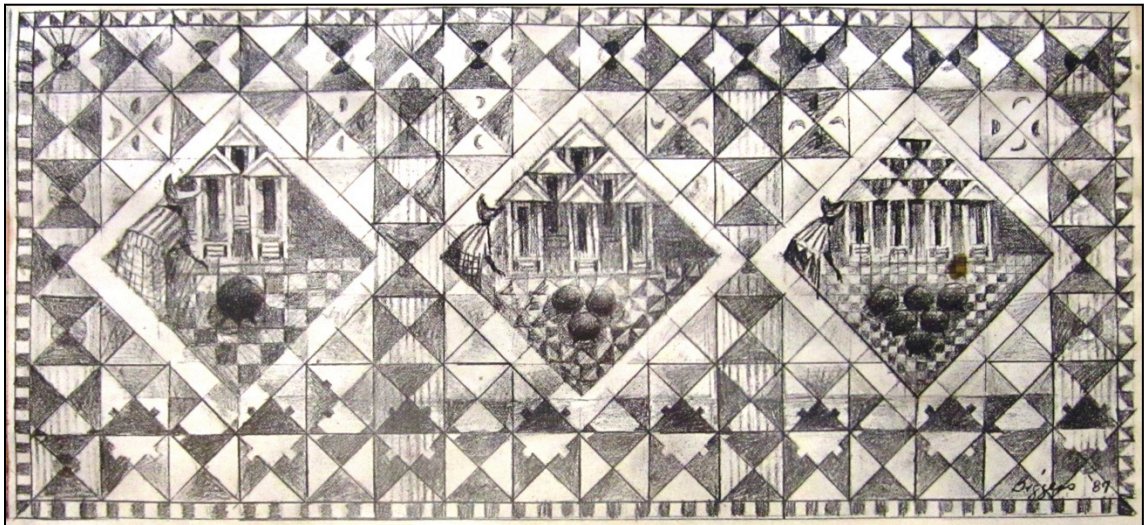


Figure 69: John Biggers, "East Texas Piecework Quilt-Sketch," 1987.



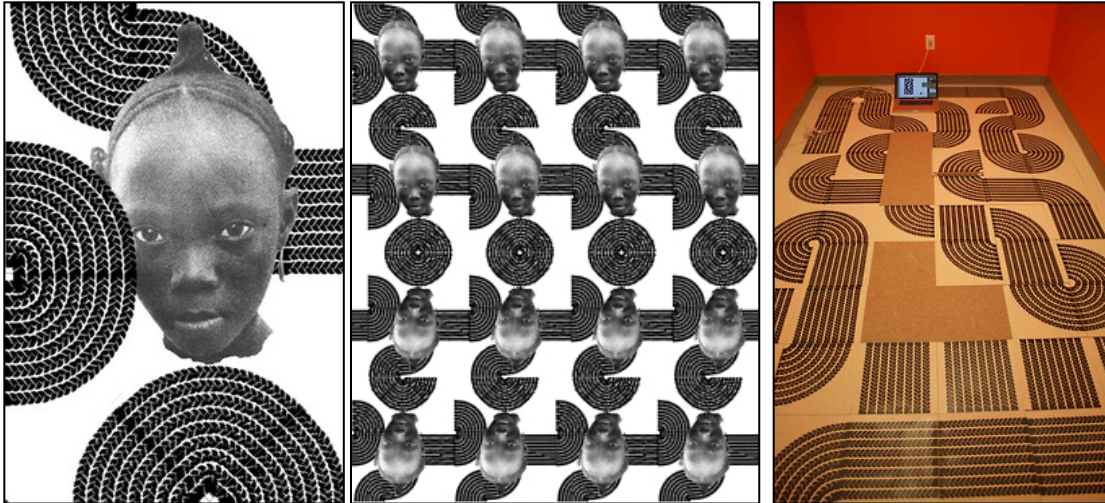


Figure 70: Nontsikelelo Mutiti. Examples of modular hair braiding related images and artifacts.

The examples presented in the STEAM learning workshops do not exhaust the possibilities of vernacular mapping as an interaction of STEM concepts, digital media and communication, and the cultural arts. Activities were designed to help participants use this technique to explore STEAM concepts. The curriculum included tools that simulate the geometric patterns sampled from artists' works to help participants explicitly map their ideas, visualize techno-vernacular creative processes, and create projects to explore their personal interests and tell stories.

#### 4.5.3. Group Discussion and Interviews

During the workshop, I conducted group discussions with participants, using an art inquiry method to encourage them to explore artworks and cultural artifacts, question what they were, and not just take them face value. After the workshop, I conducted semi-structured interviews to assess participants' affect levels, i.e. motivation intensity [Harmon-Jones, et al., 2013; Shaffer, 1996]. The interview questions were divided into the following components: 1. Affect questions about science, mathematics, art and digital media, focusing particularly on attitudes towards these disciplines, 2. A discussion of

artwork from a presentation of artists' work: students were given introductory prompts during the presentation and before the discussion [Shaffer, 1996; Genovesi, 2011].

#### **Correlation Between Research Question(s) & Interviews (6<sup>th</sup> Graders)**

<b>Global research question</b>	<b>Specific research questions</b>	<b>Interview questions</b>
Did the workshop change the participant's feelings or thoughts about STEM?	What STEM, if any, did the participant observe in the gallery art?	Did you notice any science ideas or concepts?
		Did you notice any math ideas or concepts?
		Did you notice any technology – video, music?
	How did the participant see the relation of STEM to the artwork?	Do you think the artist consciously used math, or was it more unconscious, or something in-between?
		What things might have connected the art and math – the artist's heritage? Their creativity?
		What kinds of technology, if any, did the artist use?
	How did seeing this relationship of STEM to artwork affect the student's understanding of or feelings toward STEM?	What in the workshop changed your view of science or math?
		What in the workshop changed your view of art?

Fig. 71: Correlation between research questions and interviews.

#### **4.5.4. Instruments**

As with the activities at Drew Charter School, LMS participants used the vision map template to practice TVC and STEAM concepts by remixing a base pattern to create new designs. For this study, I also created instructional toolkits that present culturally situated arts-based STEAM pedagogy using contemporary artworks, CDSTs and art-based inquiry questions. The tool kit consists of components with discreet activity units (see Fig. 72) that include the following:

- **Engagement** is the use of tools and strategies that meaningfully engage learners in STEAM activities through interaction with others and worthwhile tasks. For instance, participants look at examples and are asked to share their knowledge about remixing (i.e., in rap music and hip hop).
- **Building knowledge** is the use of information to better understand specific concepts. For example, participants complete tasks to explore remixing in other vernacular art and crafts such as traditional African American quilts.
- **Applying knowledge** is the merging of prior knowledge or with understanding of a new concept to create a project. For example, participants create vision maps and CSDT designs.
- **Reflection** refers to the time spent thinking about what was learned. For example, participants are asked to think about how their projects related to STEAM.

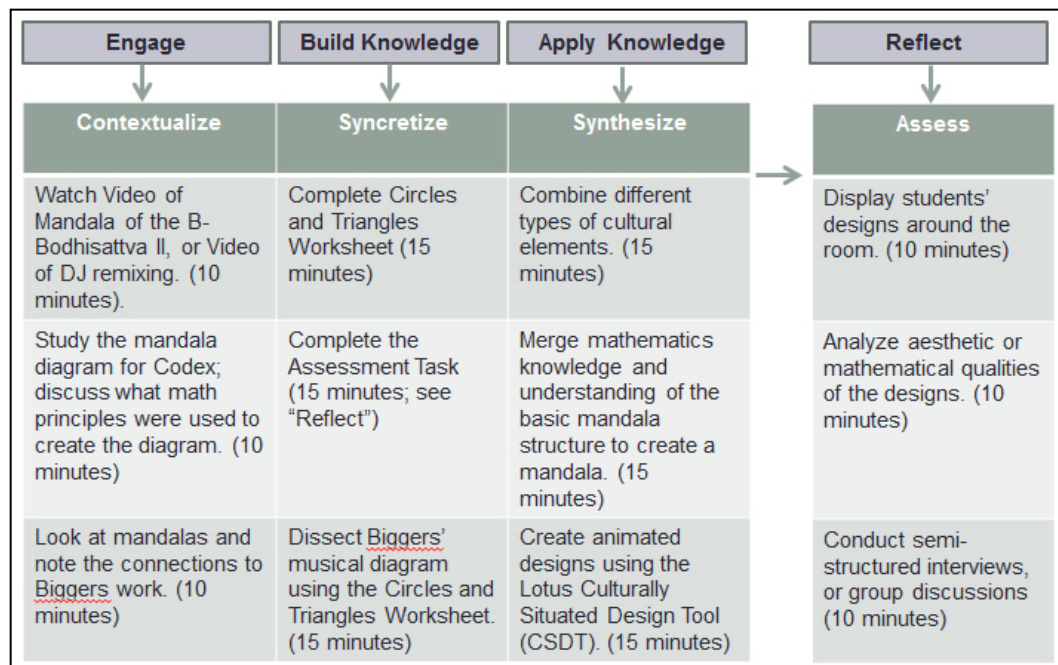


Figure 72: Instructional toolkit and activities.

With an emphasis on meaningful learning, this instructional toolkit template is consistent with culturally responsive (see Scott, Sheridan & Clark, 2014; Gay, 2010; Lee, 2007) and constructionist teaching approaches (see Harel & Papert, 1991; Kafai, 2006) and these ideas can be aligned with other situated learning theories (see Shneiderman & Kearsley, 1999). In the toolkit, teachers select from a list of activities in each unit—engagement, building, applying, reflection—and they can combine or remix activities to create their own lesson plans. The instructional toolkit was designed to support the use of CSDTs, specifically to address how cultural information can be contextualized, syncretized and synthesized for learners through the use of vernacular art and crafts and technology. Additionally, assessment tasks/units are included to evaluate the success of this form of pedagogy.

In conjunction with this study, RPI graduate student Libby Rodriguez and other developers under the supervision of Ron Eglash developed AfroFuturism CSDTs to explore the algorithms in artwork provided by Sanford Biggers, Saya Woolfalk and Xenobia Bailey. [Fig. 73]



Figure 73: Artwork used for the AfroFuturism CSDT development, courtesy of the artists.

CSDTs simulate the creative and improvisational practices of artists (and musicians) such as sampling and remixing by allowing users to import their own shapes as sprites, then drag, drop and stack script modules to create their own designs. During

workshop sessions at Lithonia Middle School and the Museum of Papermaking, participants were taught how to use these tools. For example, the Mandela CSDT allowed participants to simulate Xenobia Bailey's crocheted, colorful concentric circles, shapes and repeating patterns that draw influences from Africa, Native America and Asia.

#### **4.5.5. Retrospective Pre-Post Self-Assessment**

For this study, I designed a retrospective pre and post self-assessment to determine a change in interest and intrinsic motivation in the learning and creative processes of STEAM learning workshop participants. Prior studies have examined the effectiveness of measuring self-reported change that does not require the use of pretest prior to innovation. Research has produced strong evidence in support of retrospective pre-post self-assessment over the conventional pretest-posttest approach to measuring change [Goedhart & Hoogstraten 1992; Howard et al. 1979; Pratt, McGuigan, & Katzev 2000; Lam & Bengo 2003; Klatt & Taylor-Powell 2005; Lamb 2005]. This method of measuring change is appropriate only for self-reporting of affect—the experience of feeling or emotion based on interaction with stimuli—and cognitive change, not necessarily academic achievement. A retrospective pre-post self-assessment was created and used to better suit the free-choice (informal) learning experience and because it was seen as less intrusive by the participants.

The retrospective pre and post self-assessment for 6<sup>th</sup> grade students was designed to ask them to rate on a 5-point Likert-type scale how strongly they agree or disagree with a series of statements about their experience (see Appendix). This included attitude/mindset questions [see Dweck, 2000; Lee, Heeter, Magerko & Medler, 2012] and questions to assess whether or not there is any change in interest and motivation [Shaffer,

1996; Genovesi, 2011]. For the study, a modified version of the Instructional Material Motivational Survey (IMMS) [Keller, 1987; 2010] was created. The IMMS presumes that people are motivated to learn if there is value in the knowledge presented and if there is an optimistic expectation for success [Ely, 1983].

#### 4.5.6. Data Analysis

As with the vision mapping tool analysis, I created a rubric to assess participants' understanding of culturally situated design tools (CSDTs) based on: extent, breadth, depth and mastery (Falk & Storksdieck, 2005). This includes a part of a metric developed by Pam Hook (2012) to assess students' understanding of rotation or angle using Scratch and the TVC learning taxonomy described in Chapter 2 (section 2.6).

##### Rubric for Assessing the AfroFuturism CSDTs

<b>Extent</b>	<b>Breadth</b>	<b>Depth</b>	<b>Mastery</b>
Uses diagramming with given sample or script.	Uses different ways to remix patterns through repetition, translation, etc.	Uses media such as sound with diagramming to show deeper understanding of concepts.	Shows comprehensive knowledge or skill in diagramming and scripting.
Uses motion path that makes a right angle turn.	Uses motion path that makes a right angle turn or rotation (turn) in a different direction.	Uses rotation (turn) or 0, 90, 180, translation by height or width, or change (dilation).	Uses rotation (turn) or 0, 90, 180, translation by height or width, or change (dilation).
Creates diagram using preexisting design/script.	Creates diagram by remixing and animating a sample or sprite.	Creates diagram by remixing and animating more than one sample/sprite.	Creates diagram using more advanced scripting.
Creates animation with sample and motion path that makes one (angle) translation.	Creates animation with samples and motion path that makes multiple translations.	Creates animation with samples and motion path that makes multiple translations.	Creates animation with samples and motion path that makes multiple translations.

Fig. 74: AfroFuturism CSDT rubric.

The use of Techno-Vernacular Creativity and computing concepts in participants' CSDT designs were scored on a scale from 1-5 (low to outstanding). These results would be used to triangulate findings from other data sources.

Analysis of other workshop materials consisted of memo writing, a fundamental process of researcher/data engagement that results in a 'grounded' theory [Charmaz 2006:72]. In the memo writing process, researchers interpret data produced during project activities such as workshops. Through sorting, analyzing, and coding 'raw' data in memos, researchers explore, explicate, and theorize emergent patterns. Here, concepts were aggregated into analytic categories: Interest, Choice/Control, Expression, and Social Interaction. Excerpts of interviews were coded for expressions of affect towards STEAM and the workshop. I facilitated group discussions, interviews and administered a retrospective pre-post self-assessment (questionnaire) to analyze and assess the relationship between cultural information, contextual learning models and UEG interest and intrinsic motivation.

Categories were developed in two ways: creating general categories that come from the questionnaire and interview question(s) and more specific categories that emerge from the raw data [Marshall & Rossman, 2006]. The study reviewed relevant data and noted repeating ideas, images and observations. These were organized into themes and categories [Auerbach & Silverstein 2003]. Next, the raw data was coded into categories. Some of the data was filed into more than one category, or received no coding at all if it was not relevant to the research [Auerbach & Silverstein 2003; Marshall & Rossman 2006]. The goal was to identify five to eight categories that became the major findings for the study. Interviews from the workshops were transcribed and broken into

excerpts, where each excerpt represents one complete answer to a question [Shaffer 1996]. This helped identify ways in which different themes in the participants' experience of the workshop were related.

#### **4.5.7. Coding of Interview Data**

General questions were coded using key emic (cultural and personal) concepts and themes used by workshop participants [Shaffer, 1996]. Emic concepts were aggregated into larger analytic categories based on fundamental theoretical concepts that emerged from the data. The main analytic categories used in the analysis of the study are: Interest [Hidi & Renninger, 2006; Frenzel et al., 2010; Pugh et al., 2010], Choice/Control (linked to intrinsic motivation) [Shaffer, 1996; Falk & Dierking, 2000; Falk & Dierking, 2002], Social Interaction [Shaffer, 1996; Packer & Ballantyne, 2005], and Expression [Parker, 1894; Sidelnick, 1995]. Excerpts of videotaped interviews were coded for expressions of affect towards science, mathematics, art, technology, and the workshop, including participants' feelings about these subjects before and after the workshop, and any expression of changes in feelings towards the subjects as a result of the workshop.

The research data collected from the workshops and other related activities were analyzed using IBM SPSS Statistics version 22 for Windows and QSR NVivo 10 for Windows. Tom McKlin and SageFox Consulting analyzed *CSABL* data such as pre and post workshop surveys and social network analyses.

#### **4.5.8. Statistical Analysis**

When coding was complete, I tallied frequencies for each code [Strauss & Corbin, 1990; Shaffer, 1996; Genovesi, 2011]. Retrospective totals were compared overall,



between project activities and with multiple sources of data, and for individual participants. 6<sup>th</sup> grade student responses for affect interviews were included in the analysis of participant interest and motivation in STEM and art. The retrospective pre/post self-assessment used the Instructional Materials Motivation Scale (IMMS) with 20 items, including Attention, Relevance, Confidence, and Satisfaction. The IMMS survey was scored for each of the four subscales or the total score. The response scale ranged from 1 to 5. This means that the minimum score was 20, and the maximum is 100 with a midpoint of 60 [Keller, 2010]. The analysis of vision maps relied more heavily on the qualitative nature of the data collected [Genovesi, 2011]. Frequencies were tallied for the codes related to extent, breadth, depth and mastery (of concepts), and these would be correlated with other codes to look for relationships within the data [Falk & Dierking, 1992; 2000; Shaffer, 1996; Genovesi, 2011].

#### **4.6. Limitations/Delimitations**

There were three limitations to the study. First, the study was limited in terms of its generalizability to the total population of underrepresented ethnic groups. Like any other focus group, UEGs are a very heterogeneous population. While the study sample was diverse, certain segments of the UEG population were not included. A second limitation of the study was that the independent and dependent variables are measured as subjects' perceptions, not actual academic performance. The study was not intended to address formal learning activities, not test score performance, but rather to identify and measure subjective characteristics and perceptions related to changes in interest and motivation among UEGs in STEAM that may have occurred as a result of the workshop. Finally, the vision mapping instruments tested and developed for the preliminary and

STEAM learning workshops were based on qualitative studies, so the goal was not to capture large datasets. In other words, this study built on previously developed instruments that measure informal learning and identify specific characteristics that impact the target population for the study.

#### **4.7. Summary**

This research project took place over eight months. It explored different criteria and approaches for solving and investigating the given research problem, specifically, how Techno-Vernacular Creativity (TVC) can increase interest and motivation in STEAM among underrepresented ethnic groups (UEGs) in informal learning settings. The involvement with different communities, balanced by contributions from different creative and innovative projects, collaborators, and practitioners from diverse backgrounds, helped define what the research components were. Based on these components, I developed and employed culturally responsive tools, metrics, and inquiry questions that led to the design of an informal STEAM learning workshop. The preliminary work I conducted shaped the plan for the workshop. In the next chapter, I will present the results and findings of this effort.

## CHAPTER 5: RESULTS AND FINDINGS

### 5.1. Overview

This study investigated the role that Techno-Vernacular Creativity and innovation plays among underrepresented ethnic communities of practice (ECoPs) and underrepresented ethnic groups (UEGs) in informal learning settings. The study applied Participatory Action Research (PAR) and Constructivist Grounded Theory (CGT) methodology to integrate the theoretical frameworks and prior work that supported this project. The main purpose of this research was two-fold:

1. To identify and define techno-vernacular creative modes of practice and apply these modes to a body of work that employs culturally situated design, arts-based and digital media learning strategies to increase interest and motivation among underrepresented ethnic groups (UEGs).
2. To assess whether interest and intrinsic motivation-enhancing tactics in informal learning environments (ILEs) would have an effect on four ARCS components: attention, relevance, confidence and satisfaction.

The preliminary activities at Drew Charter School (DCS) laid the groundwork for the design of a research model that combined different learning methods and tactics that addressed the key research question: **Does Techno-Vernacular Creativity within an informal learning environment (ILE) increase interest and personal motivation in ethnic groups who are underrepresented in STEAM?**

This work led to the creation of learning opportunities for professionals from diverse fields and students who represent the target group. I designed tools and materials

and provided participants with access to various digital resources based on this work. I collaborated with professionals and Ron Eglash who guided the development of CSDTs for use in workshops I conducted in different settings. I worked with schools to recruit students for the workshops and customized a self-assessment tool to evaluate the interest and intrinsic motivation-enhancing effects of UEG experiences in the workshops.

The sections that follow detail the results of this research, or the methods used to ‘quilt the fabric’ of the study. This includes results and findings of the projects I conducted for the study, to answer the key research question. In addition to my analysis of the professional workshop an external evaluation conducted by Tom McKlin of SageFox Consulting (2014).

## **5.2. Quilting the Fabric: Research Results**

### **5.2.1. Preliminary Observations and Workshops: Drew Charter School**

The preliminary observations and workshops I conducted at Drew Charter School (DCS) achieved the goal of identifying and creating resources to sustain the target group’s interest and motivation. Conducting these activities was a way to get to know the teachers and students. During my October 2013 observations in Ms. Alyson Britt’s 4<sup>th</sup> grade math classes I took field notes and, at a later date, I conducted workshops with the same classes as part of a STEAM enrichment event in March 2014.

Participant observations in Ms. Judith Campbell’s 8<sup>th</sup> grade math classes included workshops that introduced key concepts and artwork by artists such as Sanford Biggers whose installation *Constellation (Stranger Fruit)* included various geometric designs. Ms. Campbell asked students to talk about what they saw using geometry principles such as rotation, translation, dilation and reflection. The 8<sup>th</sup> grade classes ran into technical

issues that prevented them from using CSDTs, as initially planned. As an alternative, I showed the students how to create geometric designs by layering semi-transparent paper on top of aerial satellite maps. Students traced the shapes in the maps and used additional layers to make geometric transformations. [Fig. 75] This process is similar to the one used by artist Julie Mehretu to create densely layered abstract images (see p. 110).

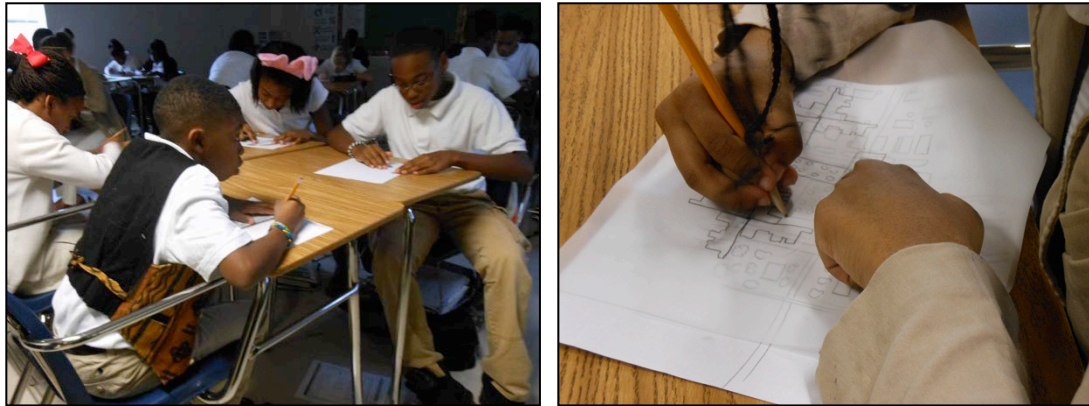


Figure 75: 8<sup>th</sup> grade preliminary STEAM workshop at Drew Charter School.

Based on information collected in Ms. Campbell's 8<sup>th</sup> grade classes, I created a vision mapping tool to help students remix quilt patterns to create new designs. During the workshops with Ms. Britt's 4<sup>th</sup> grade math classes, students used the vision map pattern as a background for collaging magazine images. They added their own text and sketches on additional layers of semi-transparent paper. Participants cut out and rearranged the squares to simulate improvisation, specifically, using the cutting and remixing to depart from the existing pattern [Snead, 1984:69]. The 4<sup>th</sup> grade students did not have access to computers or laptops but they did have iPads and were able to use the *Romare Bearden Remixes* app to create digital collages and music. [Fig. 76]

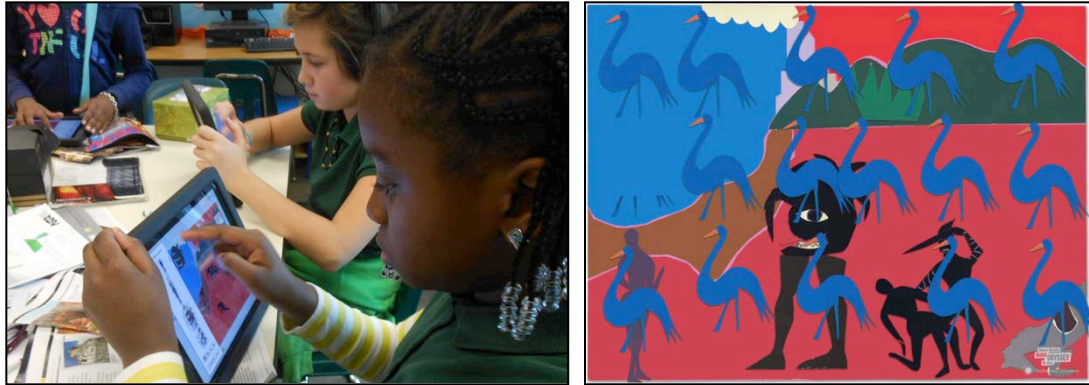


Figure 76: Left: 4<sup>th</sup> grade Drew students using the Bearden iPad app, Right: Student collage (pattern).

The activities at Drew Charter School provided essential background and contextual information for the design of an informal STEAM learning workshop. Different methods and techniques were used to explore concepts that the students were familiar with. Once interest was sparked, I noted the kinds of resources the students sought out and how to conceptualize these processes in informal learning contexts.

### **5.2.2. Professional Culturally Situated Arts-Based Learning Workshop**

For this project, I used Participatory Action Research (PAR) to conduct a professional workshop to investigate how culturally situated arts-based learning impact underrepresented ethnic learners. The aim of the workshop was to recruit experts in Learning Sciences, Culturally Situated Design, Arts and Crafts and Education to identify salient issues and make recommendations for future research. Convening experts from diverse disciplines and backgrounds addressed a concern that is supported by research that indicates that, despite many efforts and funding, historically marginalized groups continue not to enter or persist in STEM fields [Scott, Sheridan & Clark, 2014].

Researchers have called attention to the prevalence of the “imposter complex”—the feeling that one does not belong—in academia and STEM [Ong, 2010:17]. One participant mentioned having this feeling. Another participant stated,

*I am not an expert on improving STEM education. I feel that it takes a large toolkit to improve the problems that exist in STEM education. Sometimes you need a diversity of tools.*

A pre-workshop survey question addressed participants’ assessment of their ability to work with others outside of their areas of interest. One participant’s response was: *I am not an academic I am not an educator; I am not a scientist. I hope that I have something of value to offer the project. We shall see.*

Based on the evaluator’s report (2014) the professional workshop met its goal to provide a space for dialogue, engagement and collaboration. My role was identified as a “bridge between participants” that came together because of a shared interest in the research topic. Upon arriving to the workshop, one participant reported that he was *not entirely sure* why he was invited to the workshop until he met and worked with other participants, especially members of his breakout group.

This workshop included two keynote speakers, Vanessa Ramos-Velasquez and Sanford Biggers, who presented works that addressed key research methods. [Fig. 77] During his presentation Biggers reflected on the application of mathematics in his artwork:

*“My early art influences as she mentioned came from graffiti and also my cousin John Biggers, an American muralist who made a certain type of work that I thought embraced certain aspects of sacred geometry from the 1950s to the 80s.*

*His work had myriad geometrical systems and abstract and geometric references, as well as pictorial and figurative references. So as an artist, myself, I wanted to find a language that somehow captured the notion of sacred geometry and while living in Japan I got into the mandala and I was trying to find ways to incorporate with something that was autobiographical to myself growing up in Los Angeles as a graffiti artist.”*



Figure 77: Keynote speakers Vanessa Ramos-Velasquez (left) and Sanford Biggers (right).

Vanessa Ramos-Velasquez talked about working with dendrochronologists (p. 83) to build cultural narratives for new and future projects. Sanford Biggers also led a discussion for workshop participants and the community that was hosted by Georgia Tech and the Auburn Avenue Research Library for a screening of the documentary film, *The Triptych* that featured interviews with three contemporary artists from the African Diaspora, including Biggers. The segments reflected the artists' life experiences; letting viewers discover how their observations shaped the art they create. Workshop participants were invited to attend this optional event.

During the workshop, Sanford Biggers and his band Moon Medicin performed at the Georgia Tech Ferst Center for the Arts. [Fig. 78] Workshop participants met the band



backstage prior to the performance. Moon Medicin's performance demonstrated TVC practices such as reappropriation in projections of Biggers artwork, improvisation through call and response with the audience, and the conceptual remixing of sounds and images presented on stage.

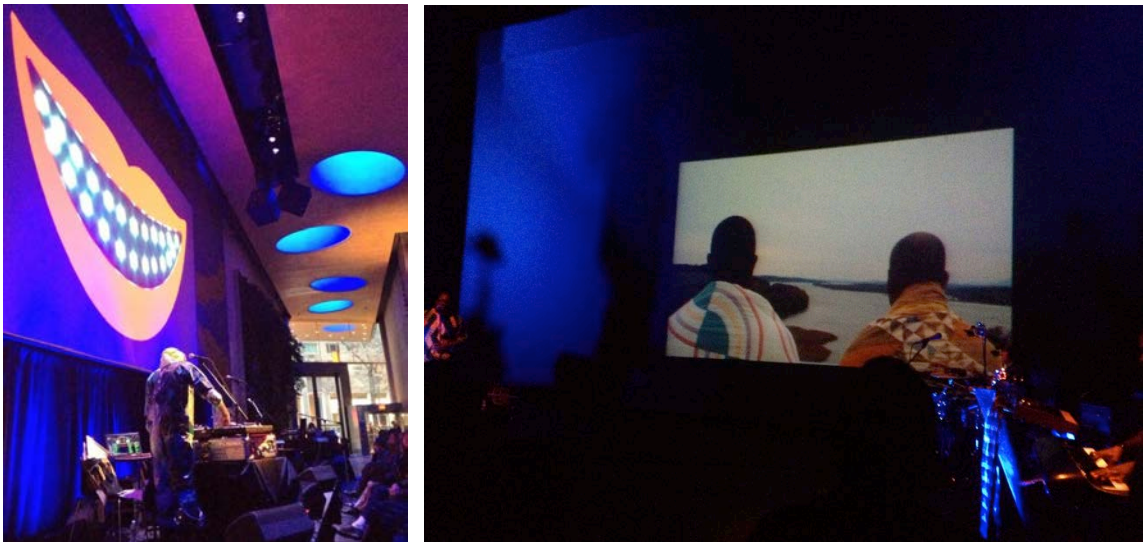


Figure 78: Moon Medicin at Lincoln Center (left) and Georgia Tech (right). Artwork by Sanford Biggers.

Participants completed surveys allowing for analysis on workshop benefits. The results of this analysis indicate that the workshop goals were achieved. The workshop feedback form is in the Appendix.

### **5.2.3. Lithonia Middle School STEAM Learning Workshop**

For the workshop at Lithonia Middle School (LMS), I used the tools and materials that were developed during the preliminary DCS activities. At LMS, I worked with 6th grade students in Ms. Lindsay Roberts' after school program to explore STEAM concepts in culturally situated artworks. As with the workshops at Drew Charter School, LMS students looked closely at different artists' works to extrapolate information such as the use of geometry to create art. Participants used vision maps to practice making iterative

geometric transformations, as well as remixing the original quilt pattern to create their own designs. [Fig. 79] The CSDTs developed at RPI enhanced this process.



Figure 79: 6<sup>th</sup> grade students creating vision maps at Lithonia Middle School.

The CSDTs used by workshop participants engaged Techno-Vernacular Creativity by remixing scripts (blocks) and animating elements (sprites) from design demos that appear when the software is launched to make new designs. [Figs. 80-81] The AfroFuturism CSDTs introduced participants to artworks that bring together cultural themes with math and computing concepts. Participants used the CSDTs on site at Lithonia Middle School and at the Georgia Tech Robert C. Williams Museum of Papermaking where they also used an interactive, multi-touch device to explore TVC modes of practice.

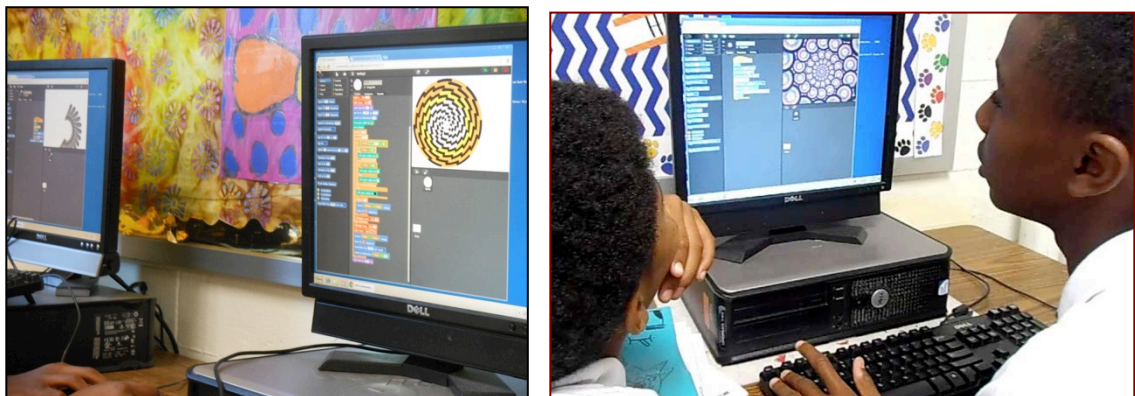


Figure 80: Lithonia Middle School students using Afrofuturism CSDTs.

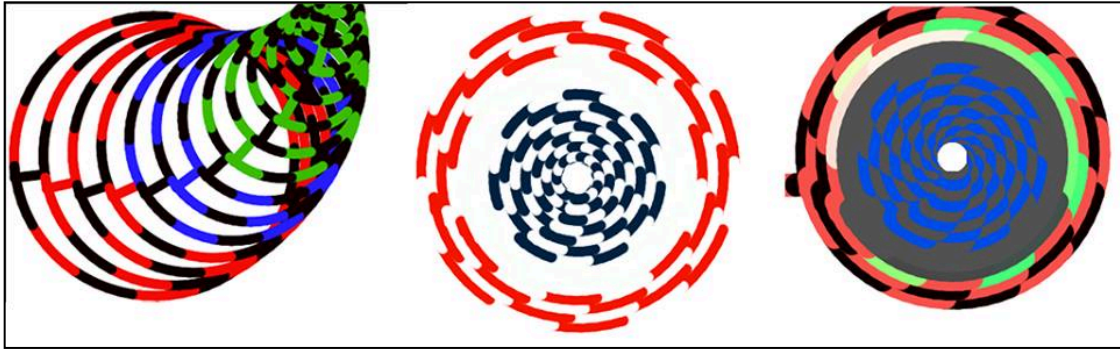


Figure 81: Examples of Lithonia Middle School students' Mandala CSDT designs.

At the Museum of Papermaking, participants learned about the traditional Lukasa memory board (see p. 74). [Figs 82-83] The digital Lukasa table helped participants “think about ways that memory can be stored in objects whose significance will only be known to a particular user or possessor, unless the meaning is shared with others [Museum of Papermaking, 2014].” Workshop participants remixed physical objects on the table to move different elements (shapes) to create animated stories that appear on the walls of the room as a type of virtual graffiti.



Figure 82: Left: Map and lukasa tour with Ken Knoespel; Right: Interactive (digital) Lukasa board, courtesy of the Georgia Tech Synaesthetic Media Lab and Museum of Papermaking.





Figure 83: Interactive (digital) Lukasa board table graphics and ‘virtual graffiti,’ courtesy of the Museum of Papermaking.

Vernacular mapping, making collages with mobile applications, creating geometric designs with CSDTs, and animating stories with interactive objects are a few ways that learners can interact with material forms and effects of technology. Using a variety of resources afforded workshop participants agency to discover Techno-Vernacular Creativity and connect STEM principles to creative works in the process. Based on interviews, metrics and the pre-post workshop self-assessment, the school-based workshops met the goal to engage underrepresented ethnic learners in Techno-Vernacular Creativity to increase their interest and intrinsic motivation in STEAM. The quantitative and qualitative results of the workshops are described in the following sections.

### **5.3. Quantitative Results: Assessment of UEG Interest and Motivation**

#### **5.3.1. Overview**

This study considered a broader definition of technology and technological practices that are pervasive among underrepresented ethnic groups (UEGs), including artists who reappropriate artifacts from different cultures, then improvise and tinker with these artifacts. This study established a link between these techno-vernacular creative modes of practice and an attitude conducive to UEG engagement with STEAM concepts through culturally situated arts-based learning activities that allow learners to manipulate

design modules using digital and non-digital tools. This section presents a summary of the quantitative analysis of the CSABL workshop and the STEAM learning workshop at Lithonia Middle School (LMS). No quantitative analysis was conducted for the activities at Drew Charter School because it was a preliminary study.

Observational components consisted of two parts: 1. Observations in workshops conducted by me and recorded either with a camera, video recorder, or with field notes. 2. Observations of vision maps and other workshop material. All notes, memos, video recordings, and materials were used exclusively for research purposes, stored in a secure location, and viewed and analyzed exclusively by researchers and advisors. This study covered multiple forms and sources of data: 1) Previously collected data such as artwork and preliminary workshop planning. 2) Data collected at the workshops described above in fall 2013 and winter/spring 2014. 3) Observation and evaluation of workshops and public events featuring work from professional artists and participants in different learning workshops during winter/spring 2014. Using Constructivist Grounded Theory (see Chapter 4 Methods) the study triangulated findings that were used in the fall 2013 and winter/spring 2014 data analysis and results phase.

LMS workshop activities were aimed at helping learners from UEGs develop their understanding of concepts related to techno-vernacular creative modes of practice. The purpose of engaging UEGs in these activities was to enhance their interest and intrinsic motivation in STEM. This section also includes a summary of the results from the CSABL workshop at Georgia Tech that involved professionals (e.g. researchers and artists) in activities to advance the understandings of the potential impacts of cultural art and technology on UEG interest and motivation.

### 5.3.2. Professional Culturally Situated Arts-Based Learning Workshop Analysis

The quantitative analysis of CSABL was conducted by Tom McKlin to capture the impact and outcomes of the workshop. This included an Executive Summary that indicated that participants felt they were able to *decrease stereotypes that might prevent underrepresented ethnic groups (UEGs) from participating in STEM and increase the motivation of UEGs to participate in STEM*. [Fig. 84] Additional work may be needed to ensure professionals understand how they might contribute to the *number of underrepresented of underrepresented students pursuing STEM careers*. This statement relates to the logic model the project team developed regarding progression of UEGs in STEAM post-secondary study and 21<sup>st</sup> century workforce skills (see Chapter 1, p. 15). More details from this summary are in the evaluator's report (2014).

Statement	Mean	n=15	
		Assessment	
1. I can describe the project's goals.	3.93	Attention ✓	
2. I can explain how I can contribute my expertise.	3.86	Attention ✓	
3. Help students see themselves as STEM professionals.	3.67	Attention ✓	
4. Decrease stereotypes that might prevent under-represented ethnic groups from participating in STEM.	4.00	Good 😊	
5. Increase motivation to participate in STEM among under-represented ethnic groups.	4.00	Good 😊	
6. Increase STEM achievement.	3.86	Attention ✓	
7. Increase the number of students in under-represented ethnic groups who pursue STEM study in college.	3.64	Attention ✓	
8. Increase the number of students in under-represented ethnic groups who pursue STEM careers.	3.33	Action !	

Note. Scale=1, strongly disagree to 5, strongly agree; Assessment: Good=Above 4.0; Attention=Below 4.0; Action=Below 3.5. Full details of each question can be found in Table 2.

Figure 84: CSABL workshop feedback summary by Tom McKlin and SageFox Consulting.

McKlin and SageFox Consulting also conducted a Social Network Analysis (SNA) that mapped and measured the relationships between the CSABL workshop

participants. Twenty-three (23) individuals completed a pre-social network analysis and fifteen (15) participants responded to the post social network analysis survey form. In both surveys participants were asked to respond to three prompts: 1) This person has influenced my thinking, 2) I have made plans to collaborate with this person in the future, and 3) I would like to collaborate with this person. Responses (pre and post workshop) were compared to determine the workshop's influence on participants' collaboration.

One hundred and nineteen (119) total connections were identified by the evaluators between individuals on the pre-SNA form. According to the information provided by the evaluator, I accounted for nearly 30% of all connections which indicated my role as a "bridge between participants" [McKlin, 2014]. Participants were also asked which individuals had influenced their thinking before the workshop and the response was greatly influenced by the bridge (the researcher). It was clear to the evaluator that there was great potential for collaboration, which was one of the main goals of the workshop.

Based on the SNA, the evaluators reported that the workshop played an important role in not only influencing individuals but also in encouraging potential collaboration [McKlin, 2014]. This analysis showed the potential for future collaborations based on the connections formed. According to the evaluators, the analysis showed that the main goals for the workshop came to fruition. More details regarding the results of the SNA are described in the evaluator's report (2014).

#### **5.3.4. Lithonia Middle School STEAM Learning Workshop Analysis**

Researchers (Falk & Dierking, 2000) note that experiences in an informal learning environment (ILE) such as a museum does not change an individual's conceptual

understanding, but it can enhance the experience by providing concrete examples of concepts and themes. For this study, I conducted a quantitative analysis of the Lithonia Middle School informal STEAM learning workshop to capture the impact and outcomes of the participants' understanding of vernacular maps and mapping. This included an analysis of vision maps to measure individual participant's conceptualization of different subjects along four dimensions—extent, breadth, depth, and mastery (see rubric in section 4.3.5, pgs. 123). These four constructs were designed by Falk and Dierking (2000) to be independent and complimentary measures of learning, capturing different aspects of learning in ILEs:

- Extent refers to the number of samples or motifs used in a pattern based on a personal concept or theme.
- Breadth refers to the number of different ways the participant combines or mixes different types of media in creative ways.
- Depth refers to more and better examples of themes to demonstrate a deeper, more sophisticated understanding of a specific concept.
- Mastery, as described by, is a more holistic assessment that takes into account all of the things a participant did or said during the process.

Barron (2006:193) notes that learning activities that take place in formal school settings are often bound to narrow time frames. Due to time and resource constraints, I did not include a control group. Students were required to participate in all of the workshop activities at Lithonia Middle School and at the Museum of Papermaking, in the same order and together in the same sessions.



Sixteen (n=16) individuals completed Vision Maps during the *STEAM Learning* workshop. All of the participants were provided with quilt design templates to create their own designs by remixing different motifs, using geometric principles such as rotation. Participants collaged these motifs (squares) on colored construction paper and created new patterns based on their own themes and concepts. 62% remixed the design template to create new patterns. 38% used the existing design with no remixing.

**Table 1: Extent (Vision Maps)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid average	6	37.5	37.5	37.5
Valid above average	9	56.3	56.3	93.8
Valid outstanding	1	6.3	6.3	100.0
Total	16	100.0	100.0	

Participants were instructed on how artists remix different types of media to create vernacular or conceptual maps. This included the use of vision mapping to explore remixing and collage. Prior to the museum visit, 37% of the middle school participants created vision map collages. All of the participants used the digital Lukasa at the museum to create their own conceptual maps. Instead of remixing the squares of the vision map, participants remixed digital beads (buttons) that represented family members and symbols with personal association. The surface of the lukasa provides a “mathematical map” for attaching these symbols in spatial patterns that facilitate interpretation [Roberts and Roberts, 1996:134]. When asked about what he created one participant stated (shape stands for physical object with fiducial marker on the bottom; button stands for multi-touch digital object):

*I used this shape to connect buttons that mean me, my mother and my community to create a story that you see here on the wall. I can tell by the color of the buttons which part is from my story.*

Another participant described the use of math in the design of the original Lukasa:

*“And they had, you had like a little African... it looks like a map because what they use to make it is related to counting. That’s what they used to make the buttons.”*

**Table 2: Breadth (Vision Maps)**

	Frequency	Percent	Valid Percent	Cumulative Percent
below average	2	12.5	12.5	12.5
average	8	50.0	50.0	62.5
Valid above average	5	31.3	31.3	93.8
outstanding	1	6.3	6.3	100.0
Total	16	100.0	100.0	

Several of the participants showed the depth of their understanding of different concepts such as the science of papermaking to vision maps and traditional cartography. One participant stated:

*Well, when we used maps and see how they made paper a while ago. Maybe about 17 thousands (17<sup>th</sup> century) you can see that they used technology to make paper. You can see how they used paper machines to make newspapers. They used technology to get it made.*

Another participant described how artists create and use maps to communicate:

*“Artists were the previous ones that invented and created maps because if you wanted to get to a particular place you usually would go to an artist and pay them to make a scale replica (of) a map so they could understand where to go.*

**Table 3: Depth (Vision Maps)**

	Frequency	Percent	Valid Percent	Cumulative Percent
below average	1	6.3	6.3	6.3
average	10	62.5	62.5	68.8
Valid above average	4	25.0	25.0	93.8
outstanding	1	6.3	6.3	100.0
Total	16	100.0	100.0	

Participants fell along a continuum between novice and expert relative to specific concepts such as remixing motifs and understanding how mapping works in different forms (traditional, digital). 37% used symbols, objects or sounds from various sources to explain new concepts. These participants were able to connect vision mapping to other culturally relevant concepts such as Lukasa memory boards. A participant who scored below average on Depth, made no connection between vision maps and Lukasa stated:

*You showed us how to move all the colors and all the plates (squares) and other stuff around.*

One participant that was scored above average (good connection) stated:

*What we did was we were making this map thing out of this technology board and it was the same as this African map that they made in the 14th century I think and we made a story using the board. Also, I forgot what the name of it was called but we made a different design out of it.*

**Table 4: Mastery (Vision Maps)**

	Frequency	Percent	Valid Percent	Cumulative Percent
below average	1	6.3	6.3	6.3
Average	9	56.3	56.3	62.5
Valid above average	5	31.3	31.3	93.8
outstanding	1	6.3	6.3	100.0
Total	16	100.0	100.0	

#### 5.3.4. Culturally Situated Design Tool Analysis

Scholars contend that sociocultural features need to be included in the development of software, the learning environment, and in what students create [Scott, Sheridan & Clark, 2014]. Culturally Situated Design Tools (CSDTs) are linked to four principles: ‘deep design themes,’ ‘anti-primitivist representations,’ ‘translation, not just modeling,’ and ‘dynamic rather than static views of culture’ [Eglash, et al., 2008]. These characteristics and tools were applied to a constructionist model (see Kafai, 1996; 2006) to investigate how and why underrepresented ethnic learners can learn through TVC processes of creating vernacular artifacts such as quilts and geometric designs.

For this study, I created a rubric and classification for learning TVC and STEAM concepts in Snap!, the platform used to develop the CSDTs. Similar to the rubric used for vision mapping, the CSDT rubric used a 5-point scale based on three measures. In this activity reappropriation refers to the repurposing of existing symbols or motifs based on a concept. Improvisation refers to the spontaneous remixing of existing components in a CSDT simulation such as the blocks, or codelets in the scripting panel. Conceptual remixing refers to moving and arranging additional blocks from the palette area and changing the inputs of the blocks to create a script for an animated design.

LMS participants had access to CSDTs at their school and at the Georgia Tech Museum of Papermaking. Due to the limited number of computers, only 50% (n=8) of the LMS participants were able to use the CSDTs and 28% used them at both sites. CSDTs extended what the participants learned during the vision and memory mapping activities by allowing them to remix specific math and computing attributes to create their own algorithm-based motifs. Some participants related the featured artist's work to math and CSDT operations (e.g. degrees of rotation, angles).

*“Artists use math because artists have to have a certain diameter like make a circle, like what we did on the computer to rotate it (shape) how many times to create the design.”*

Due to time constraints and a lack of resources (scanners, cameras) participants were not able to import their own symbols or motifs. However, they were able to use the existing CSDT demos provided through the website and make changes to the sprites in the CSDTs. 13% changed the shape, or color of their designs. All of the participants preferred the Mandala CSDT because they were able to change or use multiple colors in their designs.

**Table 5: Reappropriation (CSDTs)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Average	7	87.5	87.5	87.5
Valid above average	1	12.5	12.5	100.0
Total	8	100.0	100.0	

Half of the participants received above average scores in improvisation for remixing blocks (codelets) and using repetition, rotation (turn), translation, or change (dilation) to create their animated designs.

**Table 6: Improvisation (CSDTs)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid below average	3	37.5	37.5	37.5
Valid average	1	12.5	12.5	50.0
Valid above average	4	50.0	50.0	100.0
Total	8	100.0	100.0	

Only two of the participants tinkered with the blocks in the simulation to create new, more complex designs. They moved, removed, or added additional blocks to the scripting area to create their designs.

**Table 7: Conceptual remixing (CSDTs)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid not applicable	5	62.5	62.5	62.5
Valid below average	1	12.5	12.5	75.0
Valid average	2	25.0	25.0	100.0
Total	8	100.0	100.0	

### 5.3.5. Retrospective Pre-Post Self-Assessment Analysis

For this study, I customized the Instructional Materials Motivation Survey (IMMS) developed by John Keller (2009) to assess interest and motivational characteristics of the STEAM learning workshop at Lithonia Middle School (LMS) using the Attention, Relevance, Confidence, and Satisfaction (ARCS) model of motivation. All of the workshop participants (n=16) completed this survey. [Figs. 85-88] For each

component participants were asked to circle the number that best represents how they felt before and after the workshop.

Attention refers to learners' perceptual arousal such as using surprise to gain interest and inquiry arousal such as posing challenging questions. For Attention (atti) participants were given the following statement: *There was something interesting in the workshop that got my attention.* 75% of the respondents selected "5=All of the time."

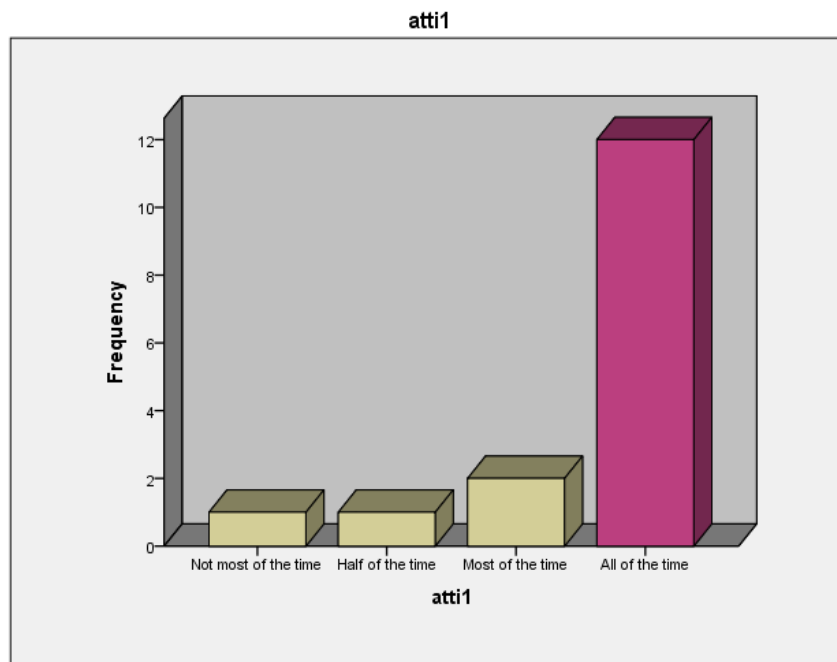


Figure 85: Attention (Retrospective Pre-Post Self-Assessment).

Relevance means the teacher/facilitator used concrete language and examples in which learners are familiar such as present knowledge and prior experience. For Relevance (rele) participants were given the following statement: *There are examples of how people use math, technology, or art in this workshop.* Nearly 44% chose "5=All of the time" and 37% chose "4=Most of the time."

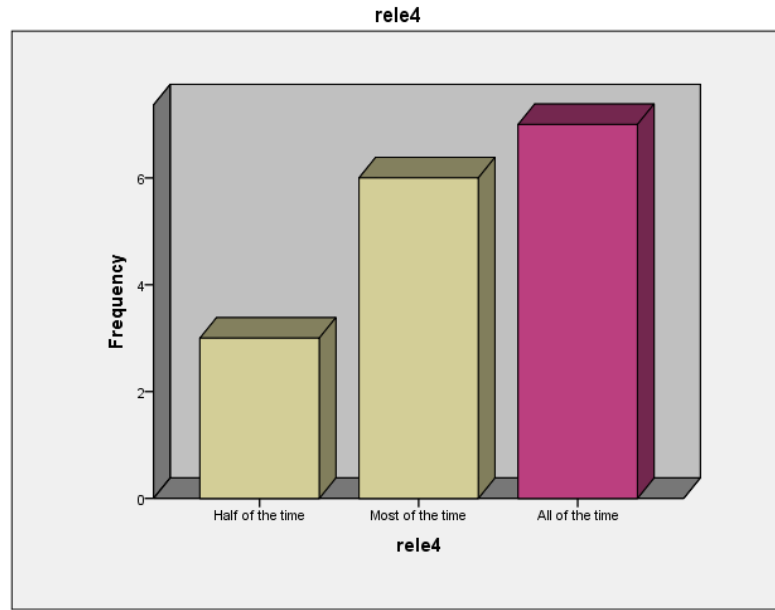


Figure 86: Relevance (Retrospective Pre-Post Self-Assessment).

Confidence means learners understand their likelihood for success; with confidence they are more willing to speak up and ask questions. For Confidence (conf) participants were given the following statement: *This workshop has things that make me want to ask more questions.* 44% of the respondents chose “5=All of the time,” nearly 13% chose “4=Most of the time” and 25% chose “3=Half of the time.”

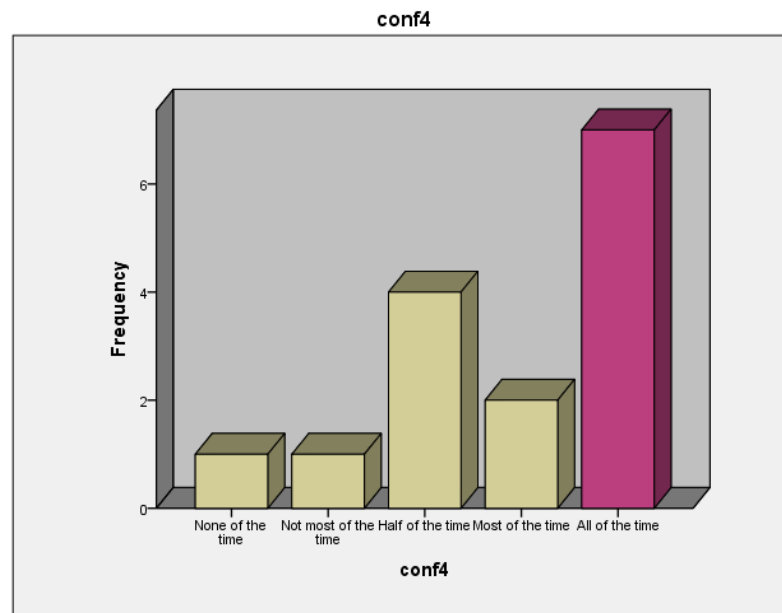


Figure 87: Confidence (Retrospective Pre-Post Self-Assessment).



Satisfaction means learners feel rewarded for their effort such as from a sense of achievement or praise. For Satisfaction (see sati3) participants were given the following statement: *I enjoyed this workshop so much that I would like to know more about this topic.* 75% of the respondents chose “5=All of the time.”

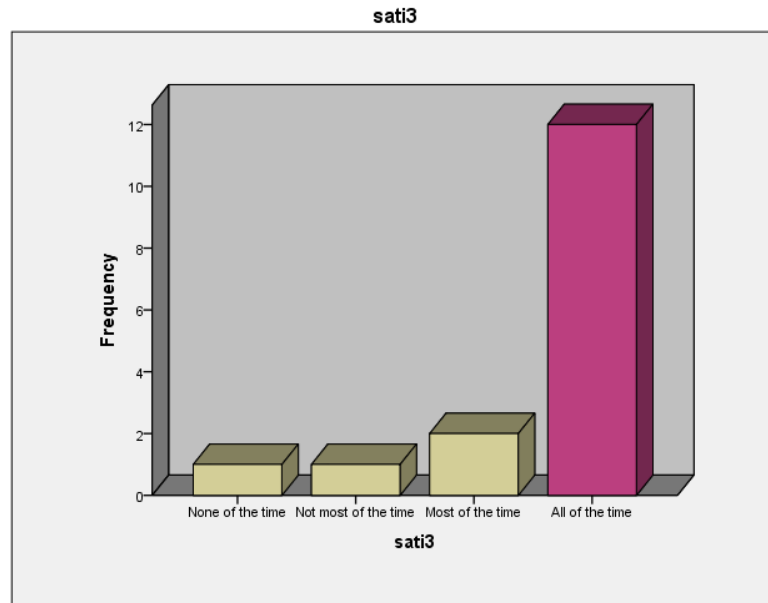


Figure 88: Satisfaction (Retrospective Pre-Post Self-Assessment).

## 5.4. Qualitative Results: How Techno-Vernacular Creativity Engages UEGs

### 5.4.1. Overview

For this study, middle school students learned how to apply modes of practice such as reappropriation, improvisation and conceptual remixing to cultural design through vision mapping, CSDTs and other digital media. At the same time they discovered that creativity was central to STEM learning and liked this new kind of learning approach. One student said simply, “*I loved everything!*” Certainly something positive and productive must have been going on if students were willing to show up for an afterschool STEAM workshop and subsequent field trip to the Georgia Tech’s Museum of Papermaking. The question was: What made these informal learning activities engaging for professionals and students from underrepresented ethnic groups?

In attempting to answer this question, the remainder of the results section describes in some detail participants' experiences during the professional and middle school workshops based on their stories and concepts, group discussions, and comments in interviews. In particular, the analysis that follows focuses on participants' expressed interests and motivations in informal learning environments, and on the relationship between interest, motivation and the creative and innovative aspects of the CSABL and STEAM learning workshops. In order to understand the role that interest and motivation play in participants' experiences of the workshops, however, we must look at their references to culturally situated design (e.g. maps) and STEAM concepts.

This section of the results begins with a brief overview of the theoretical and conceptual ideas that frame the analysis. This is followed by a description of data from the project showing the way these theories interact in informal learning environments.

#### **5.4.2. Professional Culturally Situated Arts-Based Learning Workshop Analysis**

Group activities fostered social interaction, information exchange and collaboration. In breakout groups, participants created concept maps to brainstorm ideas for culturally situated arts-based digital media applications. Each group included professional artists from underrepresented ECoPs. The artists' works were used as examples for concept mapping and brainstorming. For the analysis I created nodes in NVivo for their concepts (displayed with blue dots). [Figs. 89-91]

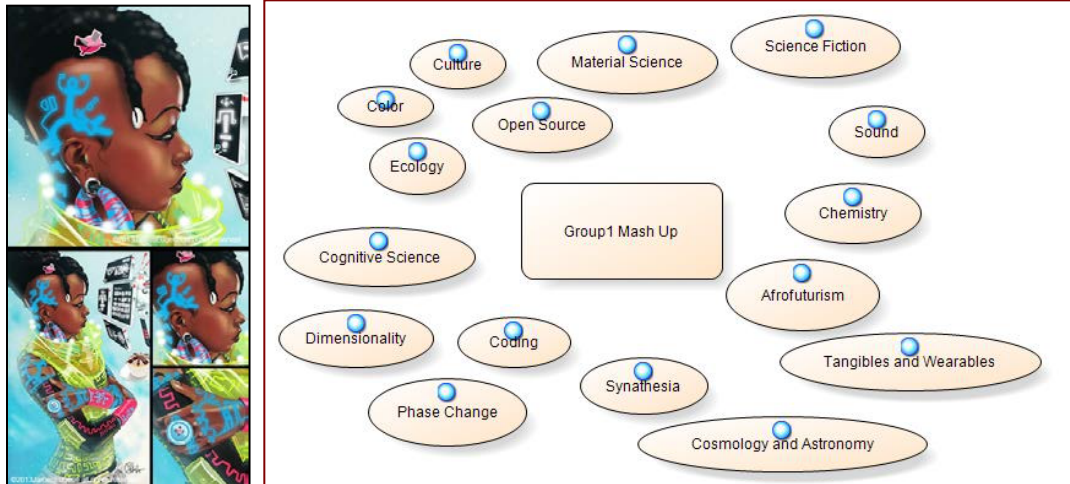


Figure 89: Breakout group 1 concept map.

Group 1 brainstormed and created a plan for an afrofuturist science fiction game *Manaka* (see above) based on a character created by artist James Eugene. In this scenario, game designers create Manaka’s technology and clothing for a scientific expedition. Each level of the game expresses scientific concepts from the concept map, with a “recombinatory” puzzle screen that can be remixed for different solutions. Manaka is culturally responsive because it identifies and nurtures the target group’s unique cultural strengths to promote STEM achievement and a sense of well-being about the group’s cultural place in the world.

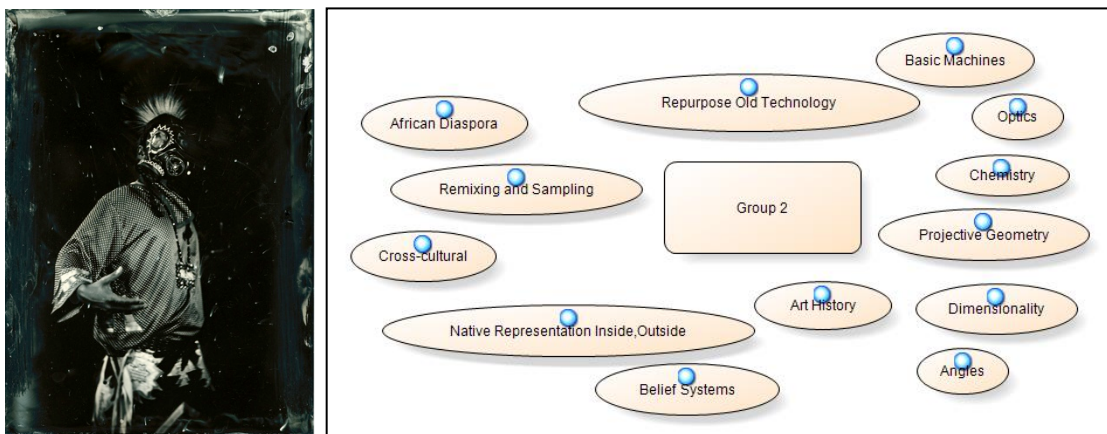


Figure 90: Breakout group 2 concept map.

Group 2 brainstormed and created a plan for a *Talking Tintype* mobile augmented reality application. In this scenario, users explore time travel based on geotagging or adding geographical identification metadata to various types of media (e.g. photographs). This app enriches, contextualizes and remixes oral traditions and visual images such as *Nimke*, a photograph by Will Wilson. The app includes performance, chemistry and optics. [Fig. 82] *Talking Tintype* is culturally responsive because it identifies the strengths of a specific underrepresented ethnic group to promote STEM achievement.

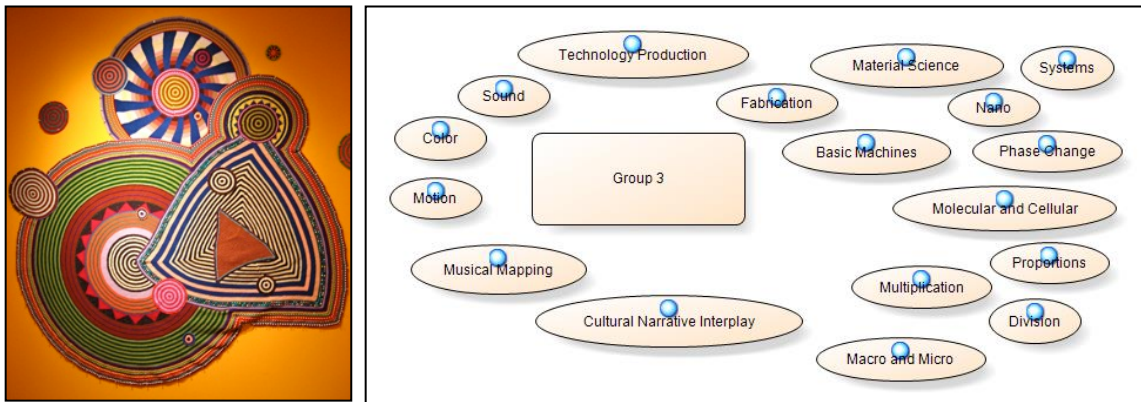


Figure 91: Breakout group 3 concept map.

Group 3 brainstormed an *X-Artist* application to generate user data visualizations of space. This app would simulate art in the “Xenobia Vernacular” or X-vernacular according to specific spatial narratives, sampling sounds and colors, and displaying bioinformatics that combines STEM to study biological data and processes. [Fig. 83] Group member Ron Eglash later led the development of the Mandala CSDT that was used by participants during the *STEAM Learning* workshop. I created an instructional toolkit based on visual elements and algorithmic designs in Xenobia Bailey’s *Aesthetic of Funk* (see above) that are simulated by the CSDT (see Fig. 16, p. 32).

### **5.4.3. Lithonia Middle School STEAM Learning Workshop Analysis**

As described in the Coding of Interview Data (section 4.5.1, p. 140), Lithonia Middle School students comments were coded using key emic concepts and themes such as “maps.” Emic concepts were aggregated into the following larger analytic categories: Interest, Choice/Control, Expression, and Social Interaction. Excerpts of the interviews were coded for expressions of affect towards science, mathematics, art, technology, and the workshop, including participants’ feelings about these subjects after the workshop, and any expression of changes in feelings towards the subjects as a result of the workshop.

Arts-based inquiry questions and informal learning approaches prompted participant’s curiosity questions (see Renninger, 2000) that led them to voluntarily explore and stretch their present understanding, in turn developing ownership and value for knowledge as well as the deepening of Interest (see section 4.2.3, p. 115). Curiosity questions are questions learners ask when they are engaged in a subject. For instance, when presented with information about cultural or vernacular maps such as traditional African American quilts or Lukasa memory boards participants who show interest ask questions to learn more about the artifact or subject. Curiosity questions can also result from “close looking,” a strategy in arts-based inquiry that encourages students to explore the artwork, question what it is, and not just take it at face value [Stott, 2013]. For the purposes of this analysis, excerpts were coded for Interest when students referred to personal stories, or when they talked about wanting to learn more about a subject.

The educational importance of learners (participants) having control over their own learning is emphasized in the work of John Dewey (1938) who wrote in great detail

about the role of freedom and social control in students' development. By "freedom" Dewey meant not only the physical freedom to move in a space, but also the freedom to make decisions, to "frame purposes" and to exercise judgment [Dewey, 1938]. Papert (1991) and others similarly emphasize the extent to which learners must control their learning experiences. For this study, excerpts were coded for Choice/Control when students referred to freedom of physical or intellectual movement, when they talked about making their own choices such as when they described the effects of their own control in their learning experience.

Expression is a process that is fundamental across many disciplines of thought [Parker, 1894]. According to Parker (1894), all means of expression are essential vehicles through which ideas in any domain are learned. The arts, as a means of expression, can be integrated throughout the curriculum. In the 110 years since Parker's work, artistic expression has moved farther and farther from the core curricula of education in the United States despite arguments by theorists such as Elliot Eisner (1987) that artistic or creative production is essential to learning. Harvey Seifter (2012) defines arts-based learning as the instrumental use of artistic skills, processes and experiences as educational tools to foster learning in non-artistic disciplines and domains. In the analysis of the STEAM learning workshop, excerpts were coded for Expression when students referred to ways in which they were able to make something that reflected their own ideas or preferences.

The importance of interpersonal interactions has a prominent place in learning theory, as seen in the work of Lev Vygotsky who saw social interaction as a critical component of cognitive development. Vygotsky (1978) argued that the "zone of proximal

development” structured learning to be appropriate to the situation of the learner, so that learners can accomplish the next step in a task with adequate adult support, or peer collaboration. Other theorists similarly argue that an essential part of learning is learning to think with others [Bruner, 1990; Pea, 1993]. For the purposes of this analysis, excerpts were coded for Social Interaction when students referred to ways in which their learning experience was affected by the active participation of others. This includes comments about getting assistance from adults or peers, collaborative work, public displays of ideas or work, group discussions or other “purely social” interactions—in short, Social Interaction refers to the range of students’ relations to other people are it connects to their learning experiences [Shaffer, 1996].

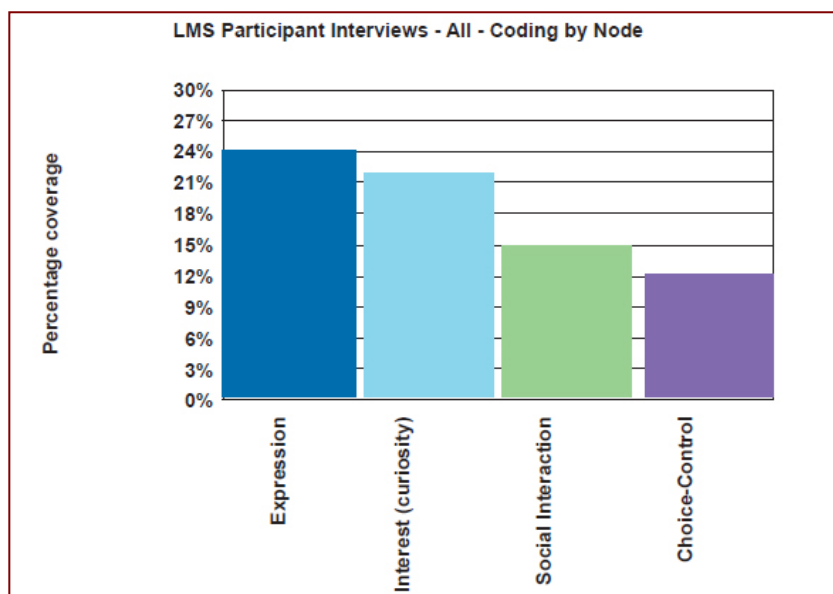


Figure 92: General analytic categories for qualitative analysis.

A look at the relative frequency of LMS participant comments in the various categories makes it clear that Expression, and with it Interest, were the most important aspects of the workshop for these participants (see Figure 92). Participants’ comments in these areas show 24% coverage for Expression and 22% coverage for Interest, with a

significant overlap. Interest is closely related to attention or learners' perceptual/inquiry arousal. Participants connected information provided during the workshop activities to their interests in art, mathematics and science. One participant commented that artists, not scientists "*make the machines that created the paper.*"

During group discussions, LMS participants were asked to look closely at Sanford Biggers' *Lotus* and talk about what they thought it symbolized:

*Students: A flower; a sun; petals.*

*Researcher (NG): What is inside of the petals?*

*Students: Fingers; arrows...what is it?*

*NG: It is a slave ship.*

*Student1: Oh!*

*NG: What does it mean? Why did he combine two images together?*

*Students: Peace; freedom for slaves; beautiful...*

Participants were also prompted to talk about maps as a group:

*NG: What is a map?*

*Student1: A map is anything that is in the area.*

*Student2: A diagram of a certain place.*

*NG: Okay. So show something that is in this particular area.*

[Several students point to different objects in the room.]

*NG: A map maker might call these things markers to tell the reader where they are on the map. What's a vision map?*

*Student3: Something that you visualize in your mind.*



There were several ways that participants talked about making their own free choices and feeling that they were they were able to make something that reflected their personal ideas and interests. For example, this participant said,

*Well, I can say it changed my perspective of art in that there are multiple ways, more ways than now and in the near future than there are in the past. You can actually use different types of material instead of just a basic pencil and paper to also create art. If you see from back then that most people used nature type things like leaves. They had to use some of those nature (natural) resources to create art.*

A week later, several participants were able to recall various sources of information they received such as how “*wood and stuff made out of trees were not originally used to make the paper*” and how to make a “*map thing out of this technology board and it was the same as this African map that they made in the 14th century.*” Social Interaction was the third category most often talked about, with Choice/Control being the last category. Most of the comments for Choice/Control focused on communication such as in the presentations (by museum staff) and group discussions.

Other areas frequently referenced by participants were science, mathematics, art, and technology. [Fig. 93] Participants commented that scientists engaged in problem solving to make the “*paper machines*” they saw on display at the Museum of Papermaking. However, most participants seemed to think that artists were the first to create these and other innovations such as maps. In fact, art showed 40% of the coverage in participant comments, with the second biggest area (math) at 21%. Technology (9%) was seen as a tool to support math and artistic expression. It is important to note here that the students recruited to participate in this workshop were volunteers. These participants

were members of special-interest clubs, meeting during after school hours. The LMS teachers combined their groups for the workshop and field trip to the Museum of Papermaking.

The workshop and field trip explored prior research (see Barron, 2006) that emphasizes the importance of looking both within and across learning settings and the importance of developing knowledge-sharing relationships. The value added by this workshop was the opportunity for the target group to ‘mess around’ with culturally situated STEAM concepts in informal learning settings.

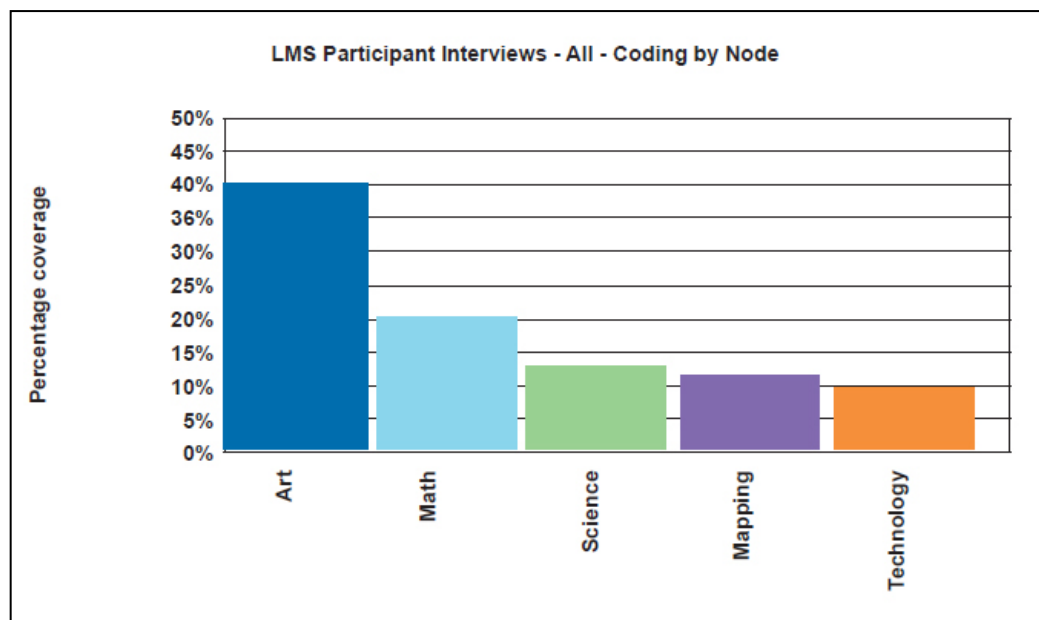


Figure 93: Middle school students' expressions of affect towards STEM.

## 5.5. Research Findings

### 5.5.1. Professional Culturally Situated Arts Based Learning Workshop

Findings from the design, implementation and evaluation of the professional workshop contributed to addressing the key research question and goals that were to:

- Engage a dialog among learning sciences researchers, STEM educators and professional artists whose work integrates informal science education through its content, methodology, and technological implementation.
- Advance the understanding of the potential impacts of culturally situated arts-based learning and research that extend participation and understanding of STEM.

During this study I was presented with an opportunity to convene experts from diverse professions and backgrounds including the arts, whose work integrates STEM. The workshop format corresponded with personal, sociocultural and physical learning contexts that are addressed in the remaining part of this section.

### ***Personal Learning Context: Hanging Out***

Whether for personal satisfaction, professional advancement, or fulfilling learning requirements for educational projects, there are increasing opportunities for culturally situated arts-based learning in informal environments. Personalized learning options and participatory learning environments are also expanding and broadening participation in STEM. Recent reports encourage measuring learning outcomes in such terms as interest, motivation, knowledge, and use of STEM content and practices, and 21st century skills [CAISE, 2014]. The results and findings of this study suggest that building the capacity for sustained collaboration and interest-driven participation among STEAM professionals can advance new approaches to and evidence based understanding of the design and development of culturally situated arts-based learning activities in informal and formal learning environments.

Background work and research consisted of artist studio visits, panels and lectures, gallery and museum exhibitions, professional and academic conferences, and

involvement in creative communities where practitioners shared and discussed their work. This investigation revealed the potential for collaboration and continued dialogue across the different disciplines—key factors in the success of this workshop. Specifically, it was the involvement of professionals from STEM fields and education with underrepresented ethnic artists that helped to establish new connections through knowledge, influence, and collaboration. During the workshop, participants related their personal interest and knowledge from their prior experiences, in their fields and communities. After the workshop, work continued to create learning opportunities to increase STEM interest and achievement among underrepresented ethnic learners.

At a later date, evaluator Tom McKlin will survey and interview CSABL participants about their continued collaborations and projects and the results of these activities will be disseminated as part of a white paper.

### ***Sociocultural Learning Context: Messing Around***

Whereas personalized learning such as hanging out in an informal learning setting fosters interest-driven participation and collaboration among professionals, sociocultural learning promotes deeper engagement with new methods, tools, and practices. Through activities that encouraged social interaction and cultural exchange, CSABL workshop participants saw themselves as active contributors even if they did not see themselves as experts. Based on post-workshop feedback responses, participants were able to overcome cultural differences, share and exchange knowledge across disciplines in a *quick building of trust*. [Fig. 94] CSABL gave professional artists an opportunity to discuss their work with experts in other fields such as computer science, mathematics and astronomy. In

turn, non-artists worked with these artists to generate ideas about how to support the growing need for STEAM engagement among underrepresented ethnic groups.



Figure 94: CSABL breakout group activity.

Participants found it helpful to learn about, explore and discuss vernacular arts, crafts and technology such as mobile augmented reality (see Chapter 3, section 3.5.2), experimental games and culturally situated design tools developed at RPI. These projects demonstrated how to foster culturally situated art-based learning among underrepresented ethnic groups. In addition to these examples, Vanessa Ramos-Velasquez’s collaboration with scientists (p. 83) and Sanford Biggers’ use of vernacular art and crafts and his involvement in techno-cultural production (p. 141) supported the goals of the workshop.

### ***Physical Learning Context: Geeking Out***

Learning is situated, or bound to the environment in which it occurs [Falk & Dierking, 2000]. Creating personal connections and interactions in a physical or online space enhances the motivation and expectations of others. This physical learning context fosters intense physical engagement with specific content and practices, or what researchers call “geeking out” [Ito, et al., 2008]. To demonstrate this context, artists

Vanessa Ramos-Velasquez and Sanford Biggers, were invited to talk to workshop participants about how they interact with STEM through culture. Collaboration and participation is important to supporting research that brings culturally situated design and arts-based learning strategies to STEM. The artists'/speakers' collaborations with STEM experts were emphasized. As a result the workshop, there was more of a sense of belongingness among the participants and more of a willingness to work with professionals from across disciplines.

CSABL workshop participants reflected on their work and created general strategic principles that can be applied to future research in the enhancement of culturally situated arts-based learning. Participants noted that the CSABL project should:

- Foster and sustain educator/researcher collaborations across disciplines. Building cross-community collaborations, e.g. education, art and STEM can also help break down existing silos.
- Help learners make connections between STEM disciplines and see the correlations that improve overall learning. As a result, learners receive a more synesthetic, relevant, less fragmented, and enriching learning experience.
- Teach multi-modal literacies. The integration of multiple modes of communication and creative expression can enhance or transform the meaning of STEM concepts.
- Provide professional development to teachers for cultural and visual literacy. This should include systematic intensive and extensive professional development for teachers, e.g. pre-service or in-service.
- I improve teacher competency to reach different types of learners.

- Create, disseminate and evaluate products to increase UEG interest in STEM.

These principles can serve as guidelines for researchers, policymakers, and educators who seek to address the underrepresentation of ethnic groups in STEM and foster opportunities that initiate culturally situated arts-based learning frameworks on a larger scale.

### **5.5.2. School-Based STEAM Learning Workshops**

Findings from the design, implementation and evaluation of the informal learning workshop contributed to addressing the key research question and investigated the participants' self-gauged success in using TVC to explore STEAM concepts. While technological fluency was a focus, these workshops went beyond technical knowledge and skills to include participants' reflections on the effectiveness of learning STEAM to meet their personal interests as a requisite for intrinsic motivation including:

1. Understanding of culturally responsive information in STEAM subjects,
2. Identification with these concepts as they relate to participants' needs, interests, goals, abilities, and cultural backgrounds,
3. Understanding of who can do STEAM and why it is relevant.

Preliminary activities emphasized the value of the participants' cultural knowledge and ideas. To extend this work, I seeded classrooms at Drew Charter School (DCS) and Lithonia Middle School (LMS) with different types of activities, material resources, and interactions. This included the use of vernacular art, crafts and technology to explore STEAM concepts. This project combined informal learning contexts for

addressing key concepts: personal, sociocultural and physical. These contexts are addressed in the remaining part of this section.

### ***Personal Learning Context: Hanging Out***

Learning is facilitated when learners' expectations are fulfilled by displays of works of art or other items of interest such as digital media [Falk & Dierking, 2000]. Preliminary activities at Drew Charter School (DCS) helped me to develop content for the learning workshop at Lithonia Middle School (LMS). The purpose of the preliminary work was to provide culturally situated, arts-based resources to capture the attention of the participants. On the dry erase board in the classroom DCS math teacher Ms. Campbell had written the word "Quilt" with a list of related math concepts. [Fig. 87] After seeing this, I created a presentation that included artworks that used these concepts. Participants were allowed to take away their math textbooks for this activity that, according to one participant, was *the first time we got to put them away*.

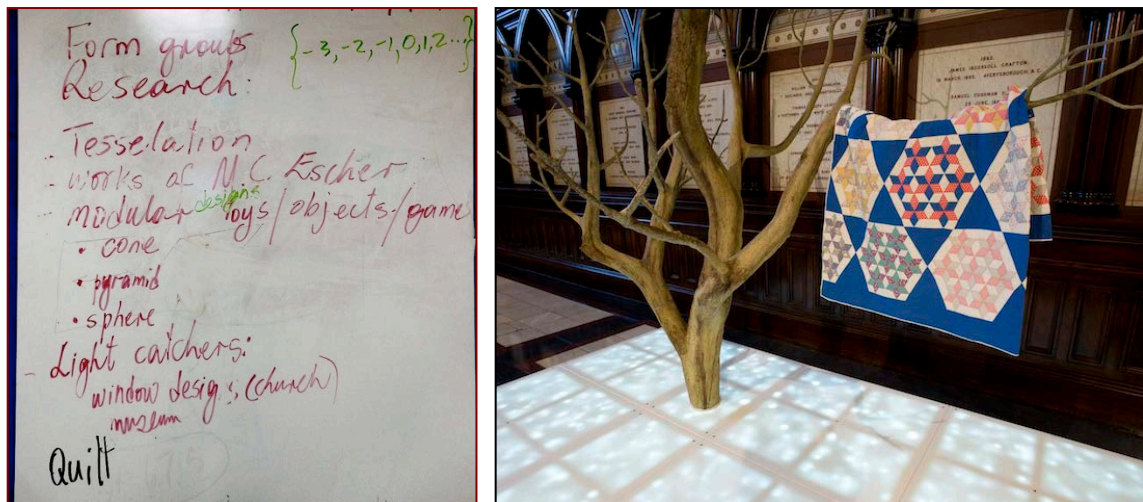


Figure 95: Left: Ms. Campbell's dry erase board, Right: Sanford Biggers, "Constellation," 2009.

Once the scene was set, I led each class in a discussion to explore artwork such as Sanford Biggers' *Constellation* (see Fig. 95) that exemplified concepts covered by the



school curriculum. Ms. Campbell asked students about what they saw in the quilt displayed in the installation using math principles. I also presented Biggers' *Lotus* as another example of geometry and symmetry. One DCS participant, after seeing the image, replied that he did not like it. When I asked him why he responded with a question: *Is he (the artist) black?* After discovering that Biggers was African American the participant immediately changed his mind about the work: *Okay, then I like it.* This change indicates that while exposure to works that address culturally relevant themes are important for underrepresented ethnic learners' self-concept and self-image, some learners needed to see themselves reflected in the artwork as well as the images of the artists, themselves. In future presentations I included photos of Sanford Biggers working in his studio.

Lithonia Middle School (LMS) teachers brought together students from the art and technology clubs for the STEAM learning workshop. Personal learning was addressed by presenting culturally responsive materials and tools that demonstrated how techno-vernacular modes of practice such as remixing could reinforce STEAM subjects such as transformational geometry, computer modeling and design. During this workshop, I asked participants to talk about how artists remix things and one participant replied: *If you see a picture you can make it your own.* The participant pointed to a poster his teacher had on display and said that he saw the same design used elsewhere. This is reappropriation. Multiple participants talked about how artists *remix everything* including music. At this point, I showed them examples of how artists remix images and objects such as the Lukasa memory board that was on display at the Museum of Papermaking.

During the group discussion participants learned about the connection between remixing and vernacular art and craft objects on which individuals tell personal stories.

*Sociocultural Learning Context: Messing Around*

“As a new media artist my work is rooted in fine arts and developed using the dynamic properties of different technologies. This being stated, digital imaging is one of the methods that play a large part in the way I choose to express these ideas. [Touré, 2014]”

Messing around is considered a form of social play in which young people engage with their peers in informal learning activities [Ito, et al., 2008:65]. Brigit Barron (2006) studied the usefulness of looking both within and across learning settings and the importance of developing knowledge-sharing relationships. This extends to Techno-Vernacular Creativity—exploring different levels of technical knowledge and innovation that UEGs bring to their world, play, and creative expression. Exploration of this area includes electronic textiles, or e-textiles (see Kafai & Peppler, 2014) that allowed workshop participants to interact with material forms and effects of technology. Designs such as Nontsikelelo Mutiti’s custom, movable floor tiles that use hair braiding and “formal qualities of repetition and diagramming (mapping)...” (see Africanah, 2014) are examples of vision mapping. This process can also be seen in work by hip-hop fashion designer Dapper Dan and in the digital designs by artist/designer Marvin Toure. [Fig. 96]

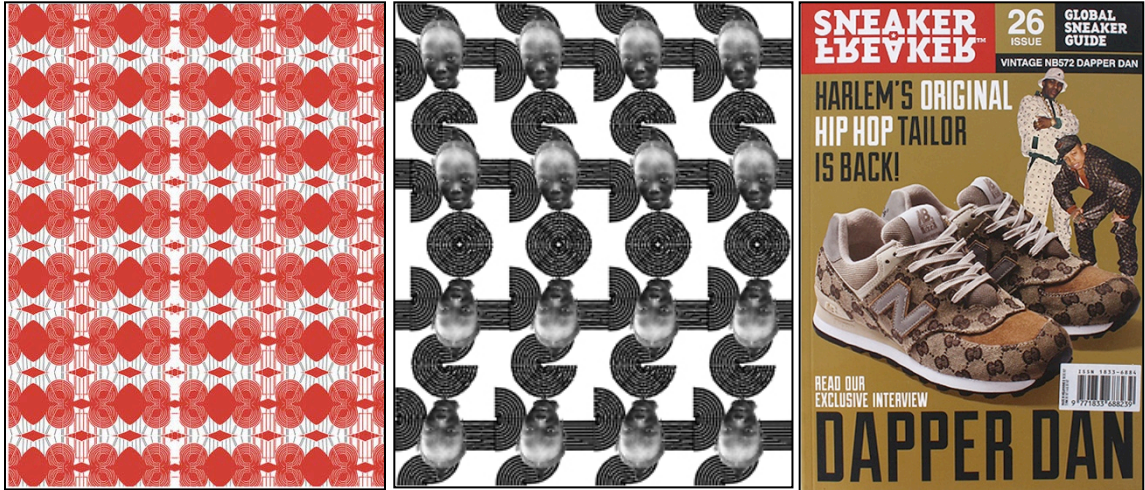


Figure 96: Marvin Toure, “1987,” 2014, Middle: Nontsikelelo Mutiti. “Ruka,” 2014, Right: Dapper Dan Sneaker Freaker cover, December 2012.

The TVC learning ecology demonstrates these creative processes and works and provides a space for experimentation with techniques such as remixing and concepts such as transformational geometry and algorithmic modeling. Workshop participants explored the ways in which contemporary artists from underrepresented communities of practice engage this production by using technology. It was also important that participants see themselves as creators who can engage with technology through TVC modes of practice, redeployment, re-creation and reconception.

Workshop participants were given access to different new media to extend and enhance what they were learning with vision mapping. DCS participants used the *Bearden Remixes* application that allowed them to transform objects from Bearden’s collages into original digital creations. [Fig. 97] I was curious about what features participants could find on their own while “messing around” with or remixing digital collages. Participants discovered how to record and loop their own voices. They figured out how to create audio mash ups that played as they made their collages. They explored repetition and rhythm techniques that artists like DJ Spooky uses.



Figure 97: DCS 4<sup>th</sup> grade students' digital collages using Bearden Remixes.

LMS participants used vision mapping and AfroFuturism CSDTs to simulate artists' designs. These activities and tools afforded participants the design agency (see p. 49) to add, take out, remix, combine or edit elements or effects with preexisting media (e.g. quilts/textiles, collages) to produce something new. Because of the ease of doing these tasks, vision mapping and digital media facilitated experimentation that, according to researchers (see Kafai & Peppler, 2014; Ito, et al., 2008), fosters interest. [Fig. 98]



Figure 98: Left: LMS 6<sup>th</sup> and 8<sup>th</sup> grade projects including vision maps, Right: LMS student's CSDT design.

One of the major challenges when planning this project was identifying and working with research sites that had flexible schedules and resources to accommodate the

STEAM learning workshop, especially access to laptops and computers. Lithonia Middle School provided the target group with a safe, secure space for hanging out and through various activities such as vision mapping and CSDT design these young people were able to express their knowledge and creativity. LMS teacher Ms. Roberts was able to acquire five desktop computers and the Center for Education Integrating Science, Mathematics, and Computing (CEISMIC) at Georgia Tech provided laptops for use at the museum. Participants used their mobile devices to record the group discussions. Participants also had the option of working individually, in pairs or small groups. [Fig. 99]

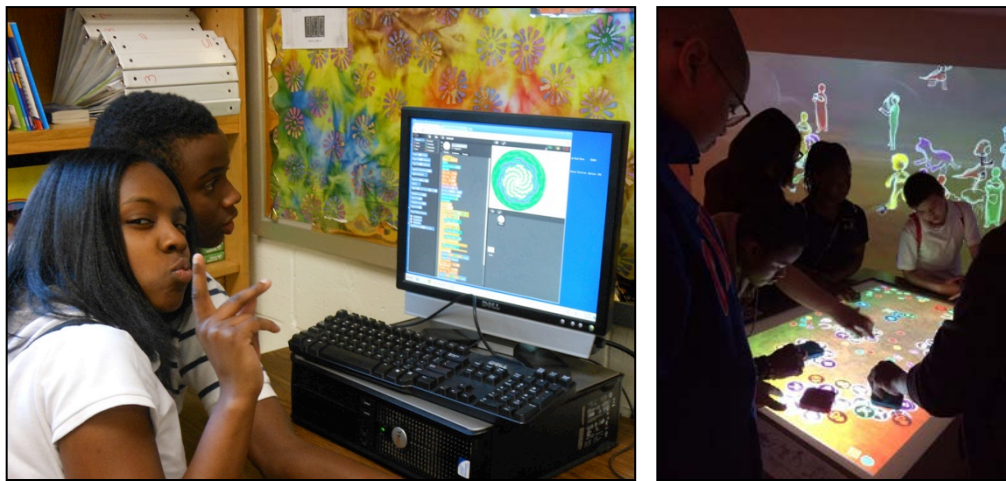


Figure 99: Left: LMS participants using a CSDT, Right: LMS students using the interactive digital Lukasa table.

At this “messing around” stage of engagement participants were learning how to remix and mashup different artifacts and simulate designs using computing and mathematics with tools such as CSDTs and a digital Lukasa table. Experimentation fostered a more “intense, media-centric form of learner engagement” [Ito, et al., 2008]. The field trip to the Museum of Papermaking reinforced personal and sociocultural learning contexts and considered multiple settings as part of the participant’s overall learning experience that led to more interest and motivation to engage in STEAM.

### ***Physical Learning Context: Geeking Out***

Physical learning is an important component of informal learning. This context was explored in this project through the close-looking method of inquiry (p. 51) and through participants' personal interactions with their peers and adults such as teachers, museum staff and me (the researcher). I spent two days observing Drew Charter School (DCS) math classes; one day observing 4th grade classes and another day with 8th grade classes. Before one class session with the 8<sup>th</sup> graders, two students arrived early and asked me questions. One student introduced himself, shook my hand and asked my name. He wanted to know what school I came from and asked me how long it took to get a Ph.D. He told me that his class was accelerated, meaning the students are taking 8th and 9th grade math. Another student, Joseph, approached me and also shook my hand. He talked about being in the accelerated group. Later, the teacher, Ms. Campbell, told me that the class workload was heavier than the other classes and students were given the option to join and leave if the work proved to be too much to handle.

The workshop activities at Lithonia Middle School prompted participants' curiosity questions (see p. 164) that lead them to voluntarily explore and stretch their prior knowledge, in turn developing ownership and value for new knowledge that, according to Renninger (2000), deepens interest. When presented with information about vernacular maps such as Lukasa memory boards participants showed interest by asking their questions to learn more about the artifact. Kenneth Knoepfel, McEver Professor of Engineering and Liberal Arts at Georgia Tech, used the close-looking method to engage participants at the museum in small group discussions about traditional and conceptual maps such as the Lukasa memory board. During one of these sessions, I noticed how



participants were copying Knoepsel's movements that indicated active participation or attention (see ARCS motivation model, p. 55). [Fig. 100] Knoepsel and museum education coordinator Virginia Howell reported that even after the activities were over the participants continued to ask *really good questions* about what they had experienced.



Figure 100: LMS small group discussion with Kenneth Knoepsel at the Museum of Papermaking.



Figure 101: LMS 8<sup>th</sup> grade students using CSDTs at the Museum of Papermaking.

During the museum visit participants continued exploring Culturally Situated Design Tools (CSDTs) with deeper, more intense engagement with the tools as before at LMS. [Fig. 98] This engagement with CSDTs encouraged participants' experimentation with digital tools or "geeking out" [Ito et al., 2008]. Individual learners contributed to their own technical skill development through diagramming, translating, patterning, and repeating digital shapes. After observing me in the classroom, LMS art teacher Ms. Roberts repeated the vision mapping activity with her 6<sup>th</sup>-8<sup>th</sup> grade classes. Ms. Roberts reported that her students were *unusually focused* during the activity. She presented the results of the activity, noting her students' use of improvisation, creating designs similar to the traditional African American quilts I presented during the workshop.

## **5.6. Summary**

Researchers have called attention to the decrease in STEM achievement among underrepresented ethnic groups (UEGs) such as in information technology-related fields [National Academies, 2011]. Scott, Sheridan and Clark (2014:2) make the case that "underrepresentation from more diverse groups hinders invention" which supports research that links innovation and creativity through underrepresented ethnic artists' TVC practices such as improvisational quilting, jazz and hip-hop. This study challenged prevailing notions regarding the digital and participation divides by highlighting work by underrepresented ethnic groups involved with a variety of techno-cultural engagements. These practices include diagramming, encoding and remixing, as well as the strategic appropriations of the material and symbolic power of technology [Fouché, 2006:641].



For the research question, the quantitative data were significant in that moderate commitment and engagement or “messaging around” with a variety of digital and non-digital tools in an informal learning workshop led to an increase in levels of expressed interest and motivation among participants of both workshops. Results were significant in that the professional CSABL workshop encouraged potential collaboration to advance new approaches to and evidence based understanding of the design and development of STEM learning in informal environments.

Quantitative and qualitative results showed that participation in a STEAM learning workshop led to high levels of interest and motivation among underrepresented ethnic learners based on surveys, group discussions and interviews. Further study that includes both an experimental and control group for underrepresented ethnic middle and/or high school students in an informal learning setting is warranted before a definitive conclusion can be drawn.

In addition, results indicated that Techno-Vernacular Creativity in an informal learning environment led to high Interest and Expression among underrepresented ethnic middle school students (p. 166). However, the coverage percentages were moderate and more interviews with students from different interest groups need to be conducted before a definitive conclusion can be drawn.

This research study suggests the feasibility of improving interest and intrinsic motivation among underrepresented ethnic learners through culturally situated arts-based learning activities that engage modes of Techno-Vernacular Creativity. Culturally situated design tools, vernacular art and crafts, interactive displays, mobile applications and other forms of digital media appear to be effective vehicles for the efficient delivery

of techno-vernacular creative modes of practice. What was unclear in this study is whether all of these modes of practice are necessary to produce similar results. This study is a starting point for future research and exploration in the development of culturally situated arts-based learning tools and methods to engage UEG learners.

Chapter 6 further discusses limitations and presents suggestions for future research.

## CHAPTER 6: DISCUSSION, CONCLUSIONS AND FUTURE WORK

### 6.1. Overview

Findings from the design, implementation and assessment of this research project contribute to answering the following key research question: **Does Techno-Vernacular Creativity within an informal learning environment (ILE) increase interest and personal motivation in ethnic groups who are underrepresented in STEAM?**

In this chapter, I will address this question in relation to the findings and discussion from the activities and reflections from professional and school-based workshops on how Techno-Vernacular Creativity, or TVC increases STEAM interest and intrinsic motivation among underrepresented ethnic groups (UEGs). In the process of answering the research question, I combined specific research models, theories and learning contexts described in Chapter 4 to design and implement these workshops. The findings of the workshops described in Chapter 5 support culturally responsive, constructionist teaching and learning approaches that impact how underrepresented ethnic learners engage with STEAM. These workshops also suggest different strategies and directions for future research.

What resulted from this research was the creation of research model to foster STEAM learning among UEGs in a variety of learning settings, and metrics for assessing this engagement through projects that explore Techno-Vernacular Creativity and innovation. In the sections that follow I will describe how I put everything together to support my thesis.

## **6.2. Putting It All Together: Discussion**

The research presented in this dissertation provides insight and moves towards answering the key research question by way of Participatory Action Research to employ a Constructivist Grounded Theory approach to informal science learning. These methods draw on design research, quantitative and qualitative methods, learning science, vernacular art, crafts and technology, including digital media. These methods have contributed to answering the key question in the following ways:

- First, by looking at Techno-Vernacular Creativity (TVC) in art, crafts and technology, I identified aspects that supported culturally responsive, constructionist teaching and learning approaches to impact how participants engaged with STEAM.
- Second, by developing a methodology for engaging these aspects, I found implications for future culturally situated arts-based learning interventions with UEGs to produce interest and intrinsic motivation in STEAM.
- Third, the study of Techno-Vernacular Creativity contributes to culturally situated arts-based learning through a Contextual Model of Learning that builds on characteristics of interest among learners as requisite for intrinsic motivation.

Based on the results of this project (p. 144, section 5.2), the professional and school-based workshops were successful and met the goals that were set. In the concluding section, I discuss the significance of these results in light of prior research and the wider implications of this work for Learning Sciences, Culturally Situated Design,

Arts and Crafts and Education. I translate what I learned from conducting the workshops, summarizing the findings of my research in relation to implications for using TVC to engage UEGs in STEAM.

### **6.3. Conclusions and Implications**

*The definition of technology needs to be expanded to include multiethnic and multilingual qualities of culturally diverse groups as they relate to STEAM.*

To better understand how UEGs engage with technology and technological practices this study looked beyond computer hardware and software to include technologies such as remixing, or tinkering with found digital and non-digital materials to create new work. Vernacular art, crafts and technologies have been devised uniquely to engage underrepresented ethnic communities through the invention of various practices such as DJs who become self-taught engineers and artists who experiment with electronic devices and musical instruments. Techno-Vernacular Creativity (TVC) produces art forms through techniques such as reappropriating, improvising and conceptual remixing with a variety of scientific and technological tools. In this study, these artworks and techniques were used to inform culturally responsive teaching and contextual learning. By educating underrepresented ethnic learners about these developments researchers, educators and policymakers can begin to narrow the gap in STEAM. Further, when conceiving of this project, I considered Beth Coleman's (2009) "race as technology"—denaturing race from historical references—and futuristic expressions of style, rhythm, dance, and the body in art, as a frame through which to see the formation of a social imaginary that disrupts existing technological systems similar to 'geeking out' and

breaking rules [Ito, 2008]. In applying the techniques of culturally and ethnically diverse artists a learning paradigm (see Eglash, et al., 2008:360) emerges in which the “praxis of social change and the theory of cultural critique” can create new forms of cultural context, syncretism and synthesis.

***Techno-Vernacular Creativity provides contexts for UEGs to learn and master tools in innovative ways.***

Members of underrepresented ethnic groups are the least likely of all groups to participate in STEM. However, many individuals from UEGs engage in TVC to produce inventions by merging aesthetic and technical production methods through redeployment, re-creation and reconception [Fouché, 2006]. This study presents contexts in which underrepresented ethnic artists and practitioners appropriate technical skills that have been using to dismantle dominant systems with “groundbreaking technologies that empower sociohistorically disadvantaged spaces” [Scott, Sheridan & Clark, 2014:17]. This study challenged arguments made by researchers that UEGs lack access to technology or lack the technical skill to narrow the digital and production divides by providing examples of works that employ STEAM. TVC practices account for the impact of media of all kinds (visual, print, digital, sound, multimodal, performance) on UEGs identity-making practices and, especially, on how text mediates their perceptions of themselves in STEAM. Underrepresented artists and practitioners provide role models for young people to re-envision themselves as technically savvy inventors and creators. Interest-driven TVC practices activate different literacies, including active engagement (see Keller, 2010) that increases the intensity of interest and motivation over time. For

example, Nelson and Tu (2001) discuss how technical skills are gained through casual use of technologies and through networks of informal apprenticeships, where peers demonstrate to each other their techniques. The types of knowledge needed to produce vernacular art, crafts and technology are rarely taught in formal education. UEGs are engaged in a dynamic range of learning opportunities that require sufficient access, time and autonomy to experiment and explore, as well as be a part of communities that support their interests. I found that creating informal learning contexts in spaces where UEGs mess around or geek out enhances their motivations and expectations. Their willingness to engage and interact through these learning contexts presents opportunities for learning and innovation.

***In order for STEAM to be motivating it has to be based on a careful match between a variety of options and the needs, interests, goals, abilities, and cultural backgrounds of the target group.***

A recent study measured students' "expressed interest," or what they say they're interested in learning, vs. their "measured interest," which was based on their responses to a series of questions designed to measure preferences for different types of "work tasks" [ACT, 2014]. Researchers in the ACT study noted the importance of aligning students' expressed and measured interests relative to postsecondary enrollment. Early assessment and intervention are extremely important in helping learners get on track for college and career success, particularly in STEM. Through vision mapping this research project explored participants' expressed interest, as well as their level of knowledge and mastery of specific concepts such as conceptual remixing and transformational geometry.

This project activity was done using a design template as a motivation for using various digital media applications. The goal was to help participants connect the dots between their personal interests and potential involvement in STEAM in the future. Although the ACT study supports some aspects of my research, it failed to consider the cultural backgrounds of underrepresented ethnic learners. Techno-Vernacular Creativity offers a way to explore UEG needs, interests, goals, abilities, and cultures in relation to STEAM learning. Informal learning contexts produce interest and intrinsic motivation in UEGs because they foster personal, sociocultural and physical interactions. This study also drew inspiration from culturally situated design (Eglash et al., 2006) and arts-based research (Barone & Eisner, 1997). I found that developing a new model that combined these approaches was necessary to engage the target group. Participants explored art, design techniques, and digital media that highlighted cultural themes and creative practices from the African, African and Latino American and Indigenous artists. Digital and non-digital tools were used to support a framework for engaging UEGs in STEAM through informal learning. This study connected underrepresented ethnic learners with creative techniques and computational tools that are usually in the exclusive domain of professional designers, artists, and engineers. Study participants used these tools to sample and remix objects to create geometric designs and animations. Some participants remixed sounds such as their voices and pre-recorded samples. Guided exploration (see Keller, 2010) and personal interpretation (see Lawrence-Lightfoot & Davis, 1997) were important aspects of this approach. Further, this project tackled the challenge of providing access to different types of digital or new media and platforms by finding research sites with adequate resources. This does not discount the use of personal (mobile) technology for



contextual learning but it should not be assumed that UEGs know about or use these applications on mobile devices on their own.

#### **6.4. Future Directions**

“By exploring “possible worlds” and “intuitions of the future” that critique the present...the author recovers purposive human time, the sense that history is not something that simply happens to us, irrespective of our will and desires, but is, indeed, ours to make. [Phillips, 2002:299]”

While this research can be considered a successful project in exploring different ways to generate the interest and intrinsic motivation underrepresented ethnic groups (UEGs) need to engage in STEAM, there were questions left unanswered: Can what was accomplished during this experimental study help to create a new field for research and practice? The overall consensus of the CSABL workshop group was that, despite the professional diversity and the short time available for the group to work together, they achieved substantial coherence, common language and integrity. The communication and interest in each participant’s specialized disciplines, and the wish to embrace a culturally situated arts-based learning framework were impressive. The final sense of the group was that this workshop represented a worthwhile opportunity to derive the maximum benefit from a deeper investigation of culture and art in STEM and build capacity for sustained collaboration across disciplines for future research and practice.

Another question to address in future research is: Can engagement with Techno-Vernacular Creativity among UEGs lead to progression into STEAM post-secondary study and skills for the 21<sup>st</sup> century workforce? In the short-term workshop, I noted an

increase in UEG interest and motivation to learn STEAM subjects. A next step would be a longitudinal study that looks at the extent to which this motivation is sustained. Do participants continue to take interest in the workings and content of STEAM subjects using TVC practices? Does this approach require ongoing and repeated exposure, or can it plant a seed that continues to grow on its own? How could an ongoing program of this type influence participant engagement in STEAM and STEM? Would such an interest ultimately lead to career paths in related fields? The ultimate goal would be to move participants from ‘hanging out,’ or ‘messing around’ to more expertise-centered forms of interest-driven ‘geeking out,’ where they are taking a proactive role in technological creation, in ways that extend their personal interests and everyday interactions.

To build on the momentum of this research, I will create a STEAM Lab at Boston Arts Academy, during the 2014-2015 school year. The Lab will be a place to play, think, and create across disciplinary boundaries; a lab with tools and materials and people for experimenting with STEAM ideas and practices; and, a space to model emerging STEAM inspired curriculum and teaching for outreach to the larger educational community. As lab director, I will be responsible for all operations of the lab, ensuring that the space serves the educational needs of students and teachers. In addition to managing a STEAM lab, I will help create a STEAM Advisory Committee to build on the professional CSABL workshop model and promote ongoing professional boundary crossing and network building in support of STEAM learning. I will also develop a master class program that will provide an opportunity for students to engage more directly with artists and practitioners in different learning settings and contexts.

Beyond the direct application of these ideas in my new position, there is also potential for other projects to grow in different directions through the direct engagement of artists, practitioners, and researchers with this work. The CSABL workshop opened up a conversation between professionals who would otherwise not have been introduced to these learning methods and contexts. In the future, I will follow-up with them on my own to see how these ideas have been integrated into their own work. They will most certainly build on this work to create their own ideas about TVC and STEAM.

## APPENDIX A

### Retrospective Pre- and Post Self-Assessment

[Adapted from *Motivational Design for Learning and Performance: The ARCS Model Approach* by John M. Keller, 2010]

#### Instructions

For each set of statements below, circle the number that represents how you felt before and after the workshop.

Example:

I like talking on the phone.      5      4      3      2      1

If you really like talking on the phone, circle 5. If you like it most of the time, circle 4. If you like it half of the time and don't like it the other half, circle 3. If you don't like it most of the time, circle 2. If you really don't like talking on the phone, circle 1.

For each question you will be asked to think about your feelings before and after your participation in the workshop.

1. When I first heard about this workshop, I had the impression that it would be easy for me.
2. There was something interesting in the workshop that got my attention.
3. This material was more difficult to understand than I would like for it to be.
4. After hearing and reading the introduction, I felt confident that I knew what I was supposed to learn from the workshop.
5. It is clear to me how the content of the material is related to things I already know.
6. There were stories, images, video, or other examples that showed me how this material could be important to some people.
7. Completing the workshop successfully was important to me.
8. The quality and type of the art helped to hold my attention.
9. As I worked on the project, I was confident that I could learn the content.
10. I enjoyed this workshop so much that I would like to know more about this topic.

11. The content of this material is relevant to my interests.
12. The way the information was presented helped keep my attention.
13. There are examples of how people use science, math, or art in this workshop.
14. This workshop has things that stimulated my curiosity.
15. I really enjoyed being in this workshop.
16. I learned some things that were surprising or unexpected.
17. The feedback before, during and after the workshop helped me feel rewarded for my effort.
18. I could relate the content of the workshop to things I have seen, done, or thought about in my own life.
19. It felt good to successfully complete the workshop.
20. The content of the workshop will be useful to me.

## APPENDIX B

### ADVANCING STEM THROUGH CULTURALLY SITUATED ARTS- BASED LEARNING WORKSHOP (MARCH 28-29,2014) FEEDBACK FORM

The goal of this workshop is to explore methods for increasing participation of under-represented ethnic groups in STEM through cultural arts. We are interested in learning the extent to which this workshop event was effective in meeting this goal..

As a result of this workshop...	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
1. I can describe the project's goals.	(1)	(2)	(3)	(4)	(5)	(N)
2. I can explain how I can contribute my expertise.	(1)	(2)	(3)	(4)	(5)	(N)
I can describe how my contributions to this project might:						
3. ...help students see themselves as STEM professionals.	(1)	(2)	(3)	(4)	(5)	(N)
4. ...decrease stereotypes that might prevent under-represented ethnic groups from participating in STEM.	(1)	(2)	(3)	(4)	(5)	(N)
5. ...increase motivation to participate in STEM among under-represented ethnic groups	(1)	(2)	(3)	(4)	(5)	(N)
6. ...increase STEM achievement.	(1)	(2)	(3)	(4)	(5)	(N)
7. ...increase the number of students in under-represented ethnic groups who pursue STEM study in college.	(1)	(2)	(3)	(4)	(5)	(N)
8. ...increase the number of students in under-represented ethnic groups who pursue STEM careers.	(1)	(2)	(3)	(4)	(5)	(N)

#### 7. WHAT ASPECTS OF THIS EVENT DID YOU FIND MOST USEFUL/APPLICABLE? LEAST USEFUL/APPLICABLE?

Most:

Least:

#### 8. DESCRIBE YOUR NEXT STEPS REGARDING THIS PROJECT:

#### 9. WHAT FOLLOW-UP ASSISTANCE DO YOU NEED TO SUPPORT YOUR EFFORTS?

#### 10. Please provide the following information:

Your name:

Your affiliation:

Thank You!

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## **VITA**

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